Ministry of Water Resources of Ethiopia

Environmental and Social Impact Assessment of about 20,000 ha Irrigation and Drainage Schemes at Megech Pump (Seraba), Ribb and Anger Dam

Environmental and Social Impact Assessment of the Megech Pump (Seraba) Irrigation and Drainage Project

Volume 1/2: Main Report (Final version)

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BRL Ingénierie

MCE

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT OF ABOUT 20,000 HA IRRIGATION AND DRAINAGE SCHEMES AT MEGECH PUMP (AT SERABA), RIBB AND ANGER DAM

ESIA of Megech Pump (Seraba) Irrigation & Drainage Project

Volume 1: Main Report

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ABBREVIATIONS

2,4-D	2,4-dichlorophenoxyacetic acid
AAU	Addis Ababa University
ABA	Abbay Basin Authority
ACSI	Amhara Credit and Savings Institute
ACT	Artemisinin Combined Therapy
ADLI	Agricultural Development Led Industrialisation Strategy
AEWA	Africa-Eurasian Waterbird Agreement
AEZ	Agroecological Zone
AIDS	Acquired Immuno-deficiency Syndrome
AISCO	Agricultural Input Supply Corporation
ANRS	Amhara National Regional State
ARARI	Amhara Regional Agricultural Research Institute
ARCCH	Authority for Research and Conservation of Cultural Heritage
ARRA	Amhara Rural Roads Authority
ARTI	Acute Respiratory Tract Infection
ASDF	Advisory Service Development Fund
ATVET	Agricultural Technical Vocational Education and Training
AWD	Acute Watery Diarrhoea
AWUA	Agricultural Water Users' Association
AWWCE	Amhara Water Works Construction Enterprise
BBF	Broadbed and Furrow
BBM	Broadbed Maker
BBOP	Business and Biodiversity Offsets Programme
BDAMFS	Bahir Dar Agricultural Mechanisation and Food Sciences
BDU	Bahir Dar University
BeSBO	Beles Sub-Basin Organisation
BFALRC	Bahir Dar Fishery and Aquatic Life Research Centre
BIU	Basic Irrigation Unit
BoARD	Bureau of Agriculture and Rural Development (ANRS)
BoCP	Bureau of Cooperative Promotion (ANRS)
BoCTPD	Bureau of Culture, Tourism and Parks Development (ANRS)
BoE	Bureau of Education (ANRS)
BoEPLAU	Bureau of Environmental Protection, Land Administration and Use (ANRS) (formerly EPLAUA)
BoFED	Bureau of Finance and Economic Development (ANRS)
BoLSA	Bureau of Labour and Social Affairs (ANRS)
BoQ	Bill of Quantities
BOT	Build-Operate-Transfer
BoWCYA	Bureau of Women, Children and Youth Affairs (ANRS)
BoWRD	Bureau of Water Resources Development (ANRS)

BP	Before Present (1950)
BPR	Business Process Re-engineering
BRLi	BRL Ingénierie
CAADP	Comprehensive Africa Agriculture Development Programme
CACC	Central Agricultural Census Commission
CBD	Convention on Biological Diversity
CBO	Community-based Organisation
CEC	Cation Exchange Capacity
CECE	Concert Engineering & Consulting Enterprise
CEEPA	Centre for Environmental Economics and Policy in Africa
CETU	Confederation of Ethiopian Trades Unions
CFA	Cooperative Framework Agreement
CGIAR	Consultative Group on International Agricultural Research
CIDA	Canadian International Development Agency
CITES	Convention on International Trade of Endangered Species of Wild Fauna and Flora
CPA	Cooperative Promotion Agency
CSA	Central Statistical Agency
CSR	Corporate Social Responsibility
CPWF	Challenge Programme on Water and Food
DA	Development Agent
DAP	di-ammonium phosphate
DCG	Drylands Coordinating Committee
DDP	Dams and Development Project
DDT	dichlorodiphenyltrichloroethane
dia	Diameter
DRM	Desktop Reserve Model
DSS	Decision Support System
EA	Environmental Assessment
EARO	Ethiopian Agricultural Research Organisation
EC	Electrical Conductivity
ECX	Ethiopian Commodity Exchange
EEPCo	Ethiopian Electric Power Corporation
EIA	Environmental Impact Assessment
EIAR	Ethiopian Institute of Agricultural Research
EIRR	Economic Internal Rate of Return
EIS	Environmental Impact Statement
EMA	Ethiopian Mapping Authority
EMAS	Eco-Management and Audit Scheme
EMP	Environmental Management Plan
EMS	Environmental Management System
ENCOM	Eastern Nile Council of Ministers
ENIDP	Ethiopian Nile Irrigation and Drainage Project

ENSAP	Eastern Nile Strategic Action Programme
ENTRO	Eastern Nile Technical Regional Office
EPA	Environmental Protection Authority
EPLAUA	Environmental Protection, Land Administration and Use Authority (now BoEPLAU)
EPSP	Environmental Protection and Sustainability Process
ERA	Ethiopian Roads Authority
ESE	Ethiopian Seed Enterprise
ESIA	Environmental and Social Impact Assessment
ESMF	Environmental and Social Management Framework
ESMP	Environmental and Social Management Plan
ESP	Exchangeable Sodium Percentage
ET	Evapotranspiration
EWCA	Ethiopian Wildlife Conservation Authority
EWNHS	Ethiopian Wildlife and Natural History Society
EWNRA	Ethio Wetlands and Natural Resources Association
FAO	Food and Agriculture Organisation
FASF	Farmers' Advisory Service Fund
FEOW	Freshwater Ecoregions of the World
FFI	Fauna & Flora International
FFS	Farmer Field School
FIDIC	International Federation of Consulting Engineers
FPME	Fish Production and Marketing Enterprise
FREG	Farmer Research-Extension Group
FTC	Farmer Training Centre
FWUA	Federation of Water Users' Associations
GARI	Gonder Agricultural Research Institute
GDP	Gross Domestic Product
GEF	Global Environment Facility
GIS	Geographic Information System
GoE	Government of Ethiopia
GPS	Global Positioning System
GRP	Glass Reinforced Plastic
GTP	Growth and Transformation Plan
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit (German Technical Cooperation)
HEW	Health Extension Worker
HIA	Health Impact Assessment
HIV	Human Immunodeficiency Virus
HPP	Hydropower Plant
HSE	Health, Safety and Environment
HTP	Harmful Traditional Practices
IA	Implementing Agency
I&D	Irrigation and Drainage

IAP	Interested and Affected Party
IAR	Institute of Agricultural Research
IBA	Important Bird Area
IBC	Institute of Biodiversity Conservation
IBSRAM	International Board for Soil Research and Management
ICID	International Commission on Irrigation and Drainage
ICOMOS	International Council on Monuments and Sites
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IDA	International Development Association
IFC	International Finance Corporation
IHA	International Hydropower Association
ILCA	International Livestock Centre for Africa (now ILRI)
ILO	International Labour Organisation
ILRI	International Livestock Research Institute (formerly ILCA)
IPA	Important Plant Area
IPM	Integrated Pest Management
IPTRID	International Programme for Technology and Research in Irrigation and Drainage
ISO	International Standards Organisation
IVM	Integrated Vector Management
IWMI	International Water Management Institute
IWUA	Irrigation Water Users' Association, IWUAs are similar to WUAs in this report
IUCN	International Union for Conservation of Nature (formerly The World Conservation Union)
IUCN-EARO	IUCN Eastern Africa Regional Office
KAP	Knowledge, Attitude and Practice
LGP	Length of Growing Period
LLIN	Long-lasting Insecticidal Net
LTTE	Lake Tana Transport Enterprise
M&E	Monitoring and Evaluation
MCE	Metaferia Consulting Engineers
MDG	Millennium Development Goals
MIC	Ministry of Information and Culture
MME	Ministry of Mines and Energy (now Ministry of Mines)
MoARD	Ministry of Agriculture and Rural Development
MoCT	Ministry of Culture and Tourism
MoE	Ministry of Education
MoFED	Ministry of Finance and Economic Development
MoH	Ministry of Health
MoI	Ministry of Information
MoLSA	Ministry of Labour and Social Affairs
MoU	Memorandum of Understanding
MoWE	Ministry of Water and Energy (formerly MoWR)
MoWR	Ministry of Water Resources (now MoWE)

MPIDP	Megech Pump (Seraba) Irrigation and Drainage Project
MSC	Management Services Contract
MWH	Montgomery Watson Harza
NABU	Nature and Biodiversity Conservation Union
NBI	Nile Basin Initiative
NBSAP	National Biodiversity Strategy and Action Plan
NEIP	National Extension Intervention Programme
NGO	Non-Governmental Organisation
NPC	National Project Coordinator
NPEW	National Policy on Ethiopian Women
NPSC	National Project Steering Committee
NRS	National Regional State
NRSCO	National Road Safety Coordination Office
O&M	Operation and Maintenance
ONRS	Oromia National Regional State
OP	Operational Policy
ORDA	Organisation for Relief and Development in Amhara
OSHWED	Occupational Safety, Health and Work Environment Dept.
PAD	Project Appraisal Document
PADETS	Participatory Demonstration, Training and Extension System
PAN	Pesticides Action Network
PAP	Project-affected Person
PASDEP	Plan for Accelerated and Sustained Development to End Poverty
PCA	Project Command Area
PES	Payment for Ecosystem Services
PIF	Policy Investment Framework
PMP	Pest Management Plan
PMU	Project Management Unit
PPD	Personal Protective Device / Planning and Programming Department
PPE	Personal Protective Equipment
PPP	Public-Private Partnership
PRA	Participatory Rapid Appraisal
PSNP	Productive Safety Net Programme
PSP	Private Sector Participation
QA	Quality Assurance
QC	Quality Control
RAP	Resettlement Action Plan
RBO	River Basin Organisation
RCBP	Rural Capacity Building Project
RDT	Rapid Diagnostic Test
REF	Rural Electricity Fund
RIDP	Ribb Irrigation and Drainage Project

RiPPLE	Research-inspired Policy and Practice Learning in Ethiopia
RPC	Regional Project Coordinator
RPCO	Regional Project Coordination Office
RPF	Resettlement Policy Framework
RPSC	Regional Project Steering Committee
RSPB	Royal Society for the Protection of Birds
SBD-W	Standard Bidding Documents - Works
SC-UK	Save the Children - United Kingdom
SDPASE	Sustainable Development of the Protected Area System
SDPRP	Sustainable Development and Poverty Reduction Programme
SEA	Strategic Environmental Assessment
SIA	Social Impact Assessment
SLM	Sustainable Land Management
SLMP	Sustainable Land Management Project
SME	Small-Medium Enterprise
SMEC	Snowy Mountains Engineering Corporation
SOP	Standard Operating Procedure
SP-IPM	Systemwide Programme on Integrated Pest Management
SRI	System of Rice Intensification
STD	Sexually Transmitted Disease
STI	Sexually Transmitted Infection
TAS	Training and Advisory System
TaSBO	Tana Sub-Basin Organisation
TB	Tuberculosis
TBD	To be determined
TBIWRDP	Tana-Beles Integrated water Resources Development Project
TEK	Traditional Ecological Knowledge
TGoE	Transitional Government of Ethiopia
TLU	Tropical Livestock Unit
ToR	Terms of Reference
UAP	Universal Access Plan
UNCCD	United Nations Convention to Combat Desertification
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UNIDO	United Nations Industrial Development Organisation
URL	Uniform Resource Locator
USBR	United States Bureau of Reclamation
VCT	Voluntary Counselling and Testing
VL	Visceral Leishmaniasis
WASH	Water, Sanitation & Hygiene
WB	World Bank
WCD	World Commission on Dams

WEAP	Water Evaluation and Planning Model
WG	Women's Group
WGS	World Geodesic System
WHO	World Health Organisation
WoARD	Woreda Agriculture and Rural Development Office
WorHO	Woreda Health Office
WPIT	Woreda Project Implementation Team
WUA	Water Users' Association, IWUAs are similar to WUAs in this report
WUBU	Water Users' Basic Unit
WUC	Water Users' Cluster
WUG	Water Users' Group
WWDSE	Water Works Design & Supervision Enterprise
WWCE	Water Works Construction Enterprise

SYMBOLS AND UNITS

^0C	degree Celsius
g	gram
ha	hectare
hr	hour
kata	0.25 ha
kg	kilogram
km	kilometre
km^2	square kilometre
kV	kilovolt
kVA	kilovolt-ampere
kW	kilowatt
kWh	kilowatt-hour
l	litre
m	metre
mg/l	milligrams per litre
mm	millimetre
m asl	metres above sea level
m^3/s	cubic metre per second
pH	acidity / alkalinity
ppm	parts per million
qt	quintal (100 kg)
s	second
t	tonne
V	volt
yr	year
µS/cm	microSiemens per cm (a measure of electrical conductivity)

Elements

C	Carbon
Ca	Calcium
K	Potassium
Mg	Magnesium
N	Nitrogen
Na	Sodium
P	Phosphorus

Monetary Units

ETB	Ethiopian Birr
EUR	Euro
USD	United States Dollar

Note 1 Euro = ~ 22 ETB as of December 2010
1 USD = ~ 16 ETB as of December 2010

GLOSSARY

Amicha	Kin-based festive labour
Aygebere	Local vernacular: medium fertility land
Bahir shesh	Cultivation of soil when soft as the floodwater recedes
Belg	Short rainy season, little rains
Buda	Category of people with the evil eye through inheritance (lower status)
Daguasa ses	Local vernacular: low fertility land
Debo / debayt	Traditional mutual help organisation
Dengal	Papyrus
Edir	Traditional savings / credit mechanism in case of death
Falasha	"the Ethiopian Jews"
Got / Gote	Village / hamlet
Guie	Practice of burning soil with crop residues to improve soil structure
Iqub	Traditional savings / credit mechanism
Injera	Pancake made from teff, millet or sorghum; traditional staple food
Kada / kata	0.25 ha of land
Kebele	Administrative area below Woreda, equivalent to sub-county or parish
Kerem't	Long rainy season, main rains
Maresha	Traditional wooden ox-drawn plough
Noug	Niger seed, an oilseed crop (*Guizotia abyssinica*)
Rega	Category of Amhara people who are 'pure' and 'noble' (higher status)
Serfej	Local water manager (covers 20-30 users)
Tankwa	Traditional papyrus boat
Teda	Weekly village market
Teff	Traditional cereal crop (*Eragrostis tef*)
Tej	Mead (fermented honey drink)
Tsiwa	Traditional faith-based organisation for commemorating saints, angels
Waïna dega	Traditional agro-ecological zone (1800-2400 m asl)
Warsa	Local vernacular: high fertility land
Woito	Marginalised, lakeshore-dependent socio-economic group
Wonfel	Reciprocal labour
Woreda	Administrative area below Zone, equivalent to District or County
Ye wuha abat	Traditional water distribution organiser/organisation ("water father")

Executive Summary

E1 The Study

This report is an Environmental and Social Impact Assessment (ESIA) of the Megech Pump (Seraba) Irrigation and Drainage Project (MPIDP). It was prepared by BRLi (France) in association with Metaferia Consulting Engineers (MCE: Ethiopia).

The project proponent is the Ministry of Water and Energy (MoWE) of the Government of the Federal Democratic Republic of Ethiopia (GoE). The project's international sponsor is the World Bank (WB). MoWE's design consultant for MPIDP is Tahal Consulting Engineers (Israel) in association with Concert Engineering and Consulting Enterprise (CECE: Ethiopia). The Resettlement Action Plan (RAP) consultant is the Snowy Mountain Engineering Corporation (SMEC: Australia).

E2 The Project

The MPIDP is located in Dembia Woreda, North Gonder Zone, Amhara National Regional State, on the north side of Lake Tana between the Megech River and the port of Gorgora. The project is intended to transform rainfed subsistence agriculture into irrigated smallholder commercial agriculture.

It is proposed that 4,040 ha of the Dembia floodplain should be irrigated by water pumped from the lake into a canal, and then distributed by gravity to approximately 2,000 farming households. This will allow improved cropping in the dry season. Associated drainage and flood protection measures will improve conditions for wet season agriculture.

The scheme will be built and operated by the government through private contractors. The GoE will (i) pay for construction using a World Bank concessionary loan, and (ii) pay the operator the full cost of off-farm operation and maintenance. User fees will be collected from farmers organised into Water Users' Associations (WUAs), with the rate gradually increasing until the full costs of operation and maintenance (O&M) are covered. Key project characteristics are listed in Table E1.

E3 The Environmental and Social Setting

E3.1 Overview

The project is located on a floodplain of Lake Tana. The command area is flat, covered by heavy clay soils, underlain by saline groundwater, regularly flooded and inaccessible for half the year. Despite this it is densely populated, with some 12,000 residents involved in a mixed farming system with a high dependency on livestock and on flood recession cropping. Economic and social relations extend outside the command area to the population of the surrounding hills.

Land holdings are small (~1 ha) and fragmented (~6 parcels/household). Social indicators (health, literacy) are low, poverty is high and cultural traditions are strong (ethnicity: Amhara; religion: Ethiopian Orthodox; staple diet: *injera*).

The two main rivers crossing the site (Nededit and Dirma) are important for fish, as is the adjacent Megech River for which a storage dam is planned. The wetlands in and around the site and the lakeshore zone are important for fish, for migratory birds and other wildlife, and for dry-season grazing, but are under pressure due to the increasing human population.

Table E1: Key Project Characteristics

Item	Data
Irrigable area	4,040 ha
Beneficiary population	~ 2,000 households, population ~ 12,000, household size ~ 6 persons
Farm size (existing & proposed)	~ 1.07 ha, fragmented, of which 57% cropped, 33% grazed, 10% other; ~ 1 ha in future, with increased % cropped
Total water demand	30-40 million m^3/yr (~7,600 m^3/ha/yr)
Main infrastructure for water supply	1 pumping station (22,750 m^3/hr), 20.7 km main canal, 59.4 km of secondary and sub-secondary canals, tertiary canals, hydraulic structures including 1 major siphon under the Dirma River, 14 night storage reservoirs
Other infrastructure	Full open drainage system including 17 drainage siphons, 87 km of service and access roads, 44 canal road crossings, flood dykes on 7 km of river
Construction period	24 months (Phase 1), 12 months (Phase 2) plus further 12 months defects liability period
Investment cost (infrastructure only)	ETB 282.21 million ~ USD 21.7 million ~ USD 5,400/ha
EIRR	18.4%
Affordability	On-farm unit water cost: ETB 0.46/m^3 (O&M, excludes capital recovery) Household cash availability after expenses: ETB 0.81/m^3 water

Source: MPIDP Final Feasibility Study (Feb. 2010), Detailed Design Report (July 2010) & draft RAP (Aug. 2010)

E3.2 Beneficiaries and PAPs

The project beneficiaries are intended to be the smallholders living in and using the cultivable land in the command area. These total some 2,000 households. Some command area land and resource users are resident outside the command area; details of their numbers and locations are not available at present.

All land users will be affected by land reallocation needed to create the rectangular basic irrigation units proposed in the layout plan. Irrigation development includes almost all settlements in the command area. Grazing resources will be reduced in favour of irrigated crops. Therefore all residents of the command area must be considered project-affect people (PAPs).

The principal vulnerable groups identified to date are female-headed households and landless women. These tend to be even poorer and more marginalised than the average household or landless person in the area, with almost no decision-making power or effective access to justice.

E4 Key Environmental and Social Issues and Impacts

The proposed project has been assessed in accordance with applicable Ethiopian guidelines and funding agency safeguard policies. It is intended to have major *positive* socio-economic impacts. These are listed in Table E2. This study focuses on identifying and mitigating potential *negative* impacts associated with project construction and operation. A number of negative impacts typical of irrigation schemes will not occur on this project (Table E3). Remaining key potential negative impacts are listed in Table E4 and discussed in the following text, by project phase. Potential solutions are summarised in Section E5 and listed in Table E5.

Table E2: Planned and Anticipated Positive Impacts during Project Operation

Planned
Increased cropping intensity on some 4,000 ha due to the provision of dry season irrigation water
Increased crop yields due to improved drainage, inputs and crop husbandry
Increased crop diversity due to an improvement of land capability by irrigation and drainage and improved access to seeds and markets
Improved livestock husbandry and productivity
Increased and stabilised household incomes from agriculture for some 2,200 farm households
Increased secondary economic activities - agriculturally-related goods and services - and associated local employment, including for scheme operation and maintenance
Improved institutional capacity of government organisations responsible for water management and agricultural development at regional, woreda and kebele levels
Improved road access, with many associated benefits
Social development, particularly due to the establishment and operation of democratic, gender-sensitive and transparent water management organisations at different levels
Reduced impacts from flooding
Anticipated, subject to implementation of relevant community development and ecosystem conservation measures
Improved adult literacy in command area due to adult literacy programmes
Improved health for command area households due to multiple health initiatives, combined with improved literacy, women's status, road access and household incomes
Improved status and quality of life of women in the command area due to multiple community development initiatives especially provision of domestic water supplies, increased household incomes, adult literacy, improved health, better access to fuel and inclusion in community decision-making mechanisms
Conservation of fish and wildlife in command area and associated rivers due to establishment of habitat protection and fishery management mechanisms and increased environmental awareness
Restoration of lakeshore ecosystem functions adjacent to command area due to lakeshore restoration programme

Source: Consultant

Table E3: Negative Impacts Unlikely to Occur

Construction	Operation
Air pollution (except dust) *Rural area, good air quality, dispersed emissions (vehicles, stationary equipment), low density of receptors)*	Limitations on irrigation water supply (but see Chapter 6 Cumulative Effects) *Water source is Lake Tana and project is relatively small*
Unreasonable noise *Rural area, night working unlikely, low density of receptors*	Poor irrigation water quality *Lake Tana water is of good quality for irrigation*
Hazards to public from use of explosives *Limited requirement for excavation of hard rock, rural area, use is regulated*	Disruption of downstream flow regimes *By itself, the project will not have significant effects on Lake Tana's hydrology (but see Chapter 6 Cumulative Effects)*
Slope destabilisation and landslides *Area is low-elevation or flat and not susceptible to mass movements (but is susceptible to surface soil erosion)*	Disruption of downstream water users *Downstream users (between the project and the lake) depend on water from the lake for dry-season agriculture, not from the project rivers*
Loss of forest habitat *No forests in area*	Changes in local climate *The project is unlikely to have any significant effect on local climate*
Price inflation of staples during construction *Labour force will be relatively small and unskilled labour will be local*	Earthquake damage to structures *The project structures are small and simple and the area is not considered at risk of severe earthquakes*
	Influx of outsiders due to better access and uncontrollable induced development *All land in the PCA is allocated and surveyed, resources are intensively used, and outsiders are highly unlikely to be permitted entry to this system*

Source: Consultant

Table E4: Key Potential Negative Impacts if Not Mitigated

Construction Impacts	
• Disruption of habitat of economically important or globally unique fishes • Potential impacts on known & unknown cultural heritage • Disruption of access by new canals and drains • Accidents and health impacts during construction	• Rapid social and economic change due to land reallocation and scheme construction • Difficulties in administering the complex land redistribution process, with possible social resistance • The social impact and cost of village irrigation and potential settlement reorganisation
Operation Impacts	
• Potential delays in irrigated agriculture development • Difficulties with in-field soil & water management • Secondary salinisation of soils • Erosion and sedimentation • Flooding and inadequate flood protection • Inadequate pest management and increased use of hazardous pesticides • Agricultural impacts on water quality • Ongoing impacts on globally important birds and fishes • Cultural constraints preventing rapid social and economic change • Impacts on women, especially increased workloads • Socio-economic impacts of the transformation of livestock husbandry	• Health impacts, especially continuing malaria and an increase in schistosomiasis • Inadequate or delayed provision of essential agricultural services and inputs including research, knowledge, credit, crop storage and processing, and links to markets • Inadequate or delayed provision of essential social services, especially health, water and sanitation, also education, road maintenance, electricity and telecommunications • Difficulties in product sales due to market inelasticity • Lack of affordability by farmers • Price reductions in local markets due to market inelasticity and associated impacts on rain-fed producers • Constraints on access due to new channels and to inadequate road maintenance • Cumulative effects on the quality and volume of water in Lake Tana

Source: Consultant

E4.1 Construction

Ecological

- Enlargement (excavation and dyking) of the Dirma and Nededit River channels will reduce available feeding and breeding habitat for catfish (*Clarias*) and Tilapia. It will not result in any direct loss of spawning habitat of migratory fishes of the genus *Labeobarbus* which are unique to the Lake Tana basin, scientifically and economically important, and under threat. However migrations could be affected by changed channel profiles, water depths, and by obstructions such as culverts, fords, and siphons.

Cultural Heritage

- The project involves earthworks and permanent land take in an area with a significant level of known cultural heritage, and surface evidence of unknown physical cultural heritage (archaeological remains such as stone tools made by Early Man). A limited ground-based cultural heritage investigation is to be carried out by the responsible Ethiopian authority (ARCCH) prior to construction. Further action will depend on the findings of this official survey.

Access

- The project involves constructing nearly 1,000 km of channels - canals and drains, of various sizes. The BoQ provides for 44 crossings on the main and secondary canals. Careful placement of these will be essential to maintain existing social and economic relations and allow the movement of livestock. Additional bridges and crossings may be necessary over both the canals and the drains to avoid disruption of local movement patterns and facilitate scheme operation.

Health and Safety

- Health, safety and environmental protection (HSE) standards on construction projects in Ethiopia tend to be below best international standards, resulting in avoidable accidents and injuries to workers and localised environmental damage. International financing of project construction and operation provides an opportunity to raise HSE standards.
- The public as well as workers are at risk from major civil engineering projects in Ethiopia such as the MPIDP, particularly local women through sexually transmitted diseases.

Rapid Change and Social Disruption

- Construction will be a major civil engineering exercise with a direct impact on some 12,000 people in the command area. Social preparation and group formation at household level is necessary to avoid (a) social resistance, and (b) impoverishment due to disruption of existing fragile production systems and livelihoods.

Land Loss, Land Reallocation and Consolidation, and Compensation

- The project's infrastructure - canals, drains, roads and flood dykes - will have a large footprint, occupying some 309 ha in total, some 7.5% of the command area. Farmers losing land to the project will require (a) crop compensation, (b) alternative land nearby, and (c) measures to ensure no loss of income/livelihood during the transition period to the new system. Since all land in the command area has already been allocated, this implies proportionate adjustment of all holdings by ~ 7.5%, reducing the average holding size within the command area to ~1.0 ha. This exercise, which is now being initiated, will be complex and socially challenging. The responsible land administration organisation (ANRS BoEPLAU) requires increased resources and capacity to undertake this exercise in keeping with Ethiopian law and Bank policy requirements.
- Following the 2005 land allocation exercise, at present each household has about 6 parcels of land of varying quality. Consultations with farmers indicate significant social resistance to the reorganisation of land if it involves land consolidation, since farmers might not receive land of equivalent quality and production risks will increase[1]. This is a very sensitive topic and will require time, resources, technical knowledge and a high level of farmer participation to resolve.

Irrigation in Villages

- The proposed irrigation and drainage layout includes settlements, which cover some 10% of the irrigable area. The scheme development concept is that all irrigable soils within the command area should be developed, therefore settlements should be reorganised to maximise the irrigation opportunities on land around homesteads. Construction of irrigation and drainage channels within settlements is associated with a number of social and operational challenges including land acquisition, channel maintenance, interrupted access, safety and, most importantly, health. It is potentially a complex exercise involving both some displacement (loss of housing) and re-arrangement of plot boundaries. Social resistance is possible. Taking a longer view, village reorganisation would provide an opportunity for improved settlement planning and upgrading (water supplies, electricity lines, etc.).

Employment

- The project will require labour for construction. Local benefits would be maximised and some of the negative impacts of construction mitigated if local residents, especially the most severely project-affected people (PAPs), are given priority for recruitment[2].

[1] As reported in the MPIDP draft Feasibility Studies (May & November 2009).

[2] As implemented successfully on the internationally-funded New Naga Hammadi Barrage Project in Egypt.

E4.2 Operation

Skills, Technologies and Labour for Scheme Uptake

- The project relies on a knowledge-, inputs- and labour-intensive model of production at the field and household level. This model is untested under the environmental and social conditions prevailing in the command area. Small-scale trials have been initiated.

Soil, Water and Land Management

- The in-field design requires the construction of ~13 km of ridges and furrows by each farmer every year at the beginning of the dry season for irrigated row crops, and (presumably) the creation of 5-6 km of broadbeds at the beginning of each wet season for traditional broadcast crops. This will require significant resources (labour, draught power, specialised ploughs) in specific time periods, and as yet is not a proven technology in the command area (see above). Applied research to identify start-up irrigation extension packages has been initiated.
- The soils in the command area are almost all vertisols, clays which expand when wet and become impermeable. The groundwater is saline at shallow depth. Incorrect water management at farm level (due to lack of skills and knowledge) and inadequate drainage (due to poor drain maintenance) could result in a rise in the water table, and consequently secondary salinisation of the topsoil.
- Vertisols are highly erodible, even on gentle slopes as in the command area. Gullying is possible and could threaten the new infrastructure. Drainage channels will slump and lose capacity. Surface water application to flush salts could cause in-field erosion.
- The catchments adjacent to the command area (the Dirma River and its tributaries, Nededit River) are in poor watershed condition with low productivity and significant surface and other forms of erosion. Sediment will continue to affect watercourses and infrastructure downstream unless watershed conditions are greatly improved.

Flooding and Flood Protection

- The proposed drainage and flood protection measures will greatly reduce the frequency and severity of flooding of the command area, if well maintained. Nevertheless, on average every 10 years the flood dykes will be over-topped (via safe spillways into surrounding land). Therefore new housing and infrastructure should be flood-resistant or only built in flood-safe locations

Pest Management and Pesticides

- Irrigation and crop intensification will change crop pest and disease patterns and intensify the need for better crop protection to maintain higher yields and quality. Unless very tightly regulated, pesticide use is likely to increase, with associated risks to human health, wildlife and water quality, including Lake Tana.

Water Quality

- Intensive commercial agriculture, unless organic, depends on high inputs of agrochemicals (fertilisers, pesticides). If used incorrectly, as is probable unless the weak regulatory regime and low level of farmer skills and equipment are upgraded, water quality will be affected with potentially serious impacts on human health and ecological values.
- The shallow groundwater (<8 m depth) in the command area is medium to highly saline with one known pocket of very high salinity. Mostly it is not suitable for either irrigation or domestic water supply.
- Channels in settled areas, especially open drains, are likely to be used for the disposal of solid and liquid wastes and for defecation. This will create a health risk, especially to small children.

Ecological

- The loss of habitat caused by channelisation of the main rivers will affect the lake fishery to some degree, specifically by reduced recruitment of catfish and Tilapia and by reduced Labeobarbus recruitment if migration to spawning sites is affected by structures and other changes to channels. Additional negative impacts on fish could occur as a result of (i) changed hydrology of the wetlands, (ii) reduced seasonally-flooded area, and (iii) pesticide runoff in drainage waters. If development of the scheme and construction of the Megech gravity project reduce informal abstraction from the Dirma River, the migratory Labeobarbus species might benefit.
- The wetlands along the Dirma River and lakeshore are important for international migratory birds, including at least three at-risk species, and especially in the dry season. Although the three main wetlands adjacent to the command area will be retained, some impacts on bird habitat will occur due to altered water regimes, channelisation, further increases in grazing pressure, and agricultural impacts on water quality.

- The lakeshore wetland zone provides a significant opportunity for a win-win conservation and livelihoods initiative, focusing on restoration of lakeshore vegetation (papyrus) and local management.

Cultural Constraints to Change

- The religious calendar, which includes a very large number of religious holidays and strict periods of fasting, may affect the availability of labour for the time-critical tasks essential for efficient crop production in modern irrigation systems. Other social factors such as gender differentiation of tasks (household, crop husbandry, livestock husbandry) and authority (decision-making is male-dominated) may affect both labour availability and the speed of social change.

Gender

- In the command area women work harder and die earlier than men. Although almost all the command area population is poor and vulnerable, women are likely to be the group most severely affected by the project due to (i) further increases in work loads, and (ii) possible exclusion from participation in new management structures due to patriarchal cultural norms. Equally, the project could provide a major opportunity for women if it incorporates gender-related components to reduce women's work loads, improve female literacy and social status, and generate household income.

Livestock

- Livestock, especially cattle, are essential for the existing mixed farming system and provide many practical, productive, economic and cultural services. However, existing feed resources and livestock health care are inadequate. The project concept relies on a major reduction in the area available for grazing in the command area and proposes fodder production and mechanisation as alternative technologies. This transformation in livestock husbandry and its socio-economic roles is likely to cause substantial short to medium term problems for a large number of households, unless it is extremely carefully planned, supported and phased.

Health

- Malaria is endemic in the area. The project is likely to change the pattern of malaria infections during the year, with an extension into the dry season.
- Schistosomiasis is endemic in the area. The project has the potential to increase the risk of infections by creating additional habitat for the snail vector and increasing exposure of the population, especially children, to water.
- The project will increase the risk of helminth infections within the irrigated area, and probably the risk of HIV/AIDS transmission at market centres.
- By itself, the project will not change the incidence of other existing serious health problems (worm infestations, trachoma, acute respiratory tract infections, diarrhoeas, etc).
- Farmers cannot be productive if they are not healthy. The project creates an opportunity to improve health conditions, but this will require both capital and operational investment in preventive and curative health care services, domestic water supplies, and sanitation and hygiene awareness. It will also require good maintenance of the planned service and access roads.

Access

- The entire scheme depends on access to the main road network for the supply of goods and services necessary as inputs and, even more importantly, for timely export of produce to markets. The scheme will have two points of access to the main road network, firstly a proposed gravel road to Guramba and thence to Kola Diba and the paved road network, and secondly to Gorgora. If one route is interrupted by erosion or flood damage the other could still be used.

Institutional

- Ethiopia has no significant experience of successful large-scale, modern smallholder irrigation[3]. The proposed management model involves (i) the MoWE and its regional and woreda-level counterparts as owner of the pumping station, the primary and secondary canal systems, the off-farm drainage system and the flood control measures, (ii) a private sector organisation (Private Sector Participation (PSP) contractor) paid by GoE to operate and maintain the off-farm components of the scheme and provide support to farmers, (iii) Irrigation Water Users' Associations to operate the tertiary and on-farm irrigation and drainage systems and pay a fee for water to GoE through the operator to cover the operator's O&M costs, and (iv) MoARD and its regional and woreda-level counterparts to be the service providers, either directly or through commercial service and input organisations that would be established in the project area. This arrangement is experimental and carries many risks, particularly those relating to (a) cost recovery, (b) effective O&M of the on-farm systems, and (c) the quality and availability of knowledge services and the many other inputs necessary for sustainable and productive irrigated agriculture.
- As yet details of some of the measures necessary for successful operation of the scheme, including establishment and operation of all the 'software" - the organisations required to provide agricultural inputs, services and links to the markets as well as the essential non-agricultural services (water supplies, literacy, health etc.) - and some important project components such as livestock husbandry - are not available.

Economic

- Economic analysis of the scheme at feasibility level indicates that although recovery of the capital investment in irrigation infrastructure will not be affordable at household level, farmers will be able to pay the full cost of off-farm O&M after the transition period to full production.
- Marketing is a key issue in relation to the success of the scheme. Local markets are small, with the principal opportunities being seen in import substitution, especially for rice, and exports, especially of niche products such as pulses and oilseeds.
- Due to market inelasticity, the increased production from the command area is likely to affect the prices and saleability of similar produce from other producers nearby, with potentially significant negative impacts on profits and incentives for production. This will apply, in particular, to perishable crops subject to damage during transport such as tomatoes and some other fresh vegetables.
- Modern small-scale irrigation schemes depend on non-agricultural as well as agricultural and financial services for their success, in particular improved provision of health, domestic water, adut literacy, roads, electricity and telecommunications. At present the quality and coverage of these services in and around the project area is low. They need to be improved but are dependent on government budgets. Additional investment in the project area would divert funds from other needy areas and increase inequality. Therefore it is important that alternative funding and delivery mechanisms for these essential services are found and implemented (for example, as part of the operator's contractual duties).

Cumulative Effects

- Water abstraction for the scheme will marginally reduce the net water volume available in Lake Tana (because of consumptive use by crops). In itself, this will not affect downstream water users on the Blue Nile, but when combined with other existing and planned water abstractions from the Lake Tana sub-basin, it will contribute to probable significant impacts on water availability in dry years.
- Unrestricted operation of the Tana-Beles water transfer will have a major effect on lake water levels in future dry years, with impacts on navigation and tourism, wetlands, and lakeshore farmers.

Transboundary Effects

- The MPIDP will not have any significant hydrological effect downstream at the border with Sudan because the contribution of the Lake Tana sub-basin to total flow in the Abbay River (Blue Nile) in Ethiopia is very low. However, when combined with the numerous other abstraction and water regulation projects planned for the overall Abbay Basin, the MPIDP will have measurable cumulative effects on dry season flows at the border.

Alternatives

- Large-scale gravity irrigation of the project area is not possible since all water from the planned Megech Dam will be allocated to areas upstream of the Megech (Seraba) command area.

3 The Koga Irrigation Project has run into many problems and is only just starting operations.

- Pressurised irrigation would use less water and create lower risks of salinisation, but is an expensive and complex technology unlikely to be practical under foreseeable social and market conditions for smallholders.
- Small-scale irrigation of the area already exists and could be improved and extended at relatively low cost, but with potential impacts on some fish species due to water abstractions from the rivers.
- Agricultural productivity and living standards in the command area could be significantly improved without large-scale irrigation by providing (i) farm to market road access, safe domestic water, rural electricity, better health services and universal literacy, together with (ii) improving crop and animal husbandry techniques, supplies and services such as cultivation practices, field drainage, flood protection, crop protection, fertiliser availability, seeds, credit, crop processing and storage, marketing, improved breeds, and veterinary care. These improvements and services will be required both with and without the project if sustainable socio-economic development is to be achieved in the project area.

E5 Environmental and Social Management Plan

Solutions to the key impacts outlined above are summarised in Table E5, based on a standard impact assessment approach of (i) avoid, (ii) minimise, (iii) compensate, and (iv) enhance. The table also indicates responsibilities for the various measures. Full details are provided in the main text.

Table E5: Outline of ESMP - Key Mitigation Measures

Potential Impact	Key Mitigation Measures	Responsibility
Construction		
Direct impacts on fish habitat	(i) ensure main cross-drainage structures and road crossings allow fish passage, (ii) avoid drainage of existing main wetlands on Dirma River	MoWE
Potential impacts on known and unknown cultural heritage	(i) ground-based survey prior to construction, (ii) earthworks supervision by archaeologist, (iii) chance find procedures in tender documents, (iv) keep stakeholders informed	MoWE, ARCCH, PSP contractor
Disruption of access by new canals and drains	(i) construct additional crossings as needed	PSP contractor
Health and safety hazards and potential environmental pollution during construction	(i) incorporation of specific HSE provisions in the tender documents, (ii) provision of both financial incentives and compliance mechanisms in the tender documents, (iii) provision of HSE supervision resources, (iv) STD and HIV/AIDS awareness and prevention campaigns for both workers and local residents, targeted at high-risk groups	MoWE, ANRS BoH
Loss of land and other assets	(i) intensive efforts to establish functioning IWUAs, (ii) detailed participatory planning in advance of construction involving all affected land users to cover (a) land acquisition and reallocation, (b) compensation amounts and procedures, (c) construction procedures and timing, and (d) arrangements to minimise disruption of seasonal agricultural activities, (iii) advance notice of all construction activities	MoWE, PSP contractor, BoEPLAU
Social dislocation and social resistance due to land reallocation and agricultural disruption	(i) detailed participatory planning and social preparation (see above), (ii) support for most vulnerable affected households	MoWE, PSP contractor, BoEPLAU
Disruption and health hazards of irrigation in settlements	(i) exclude settled areas from first phase of development	MoWE

Potential Impact	Key Mitigation Measures	Responsibility
Employment of outsiders	(i) identify and categorise PAPs, (ii) include most severely-affected PAPs onto lists for recruitment priority, (iii) require contractor to give priority to PAPs on lists supplied, (iv) close monitoring	MoWE, Kebeles, BoEPLAU, PSP contractor
Operation		
Delayed uptake due to inadequate skills, labour, technologies	Carry out a full-scale farm level trial for at least one full agricultural year before implementation of the on-farm aspects of the scheme (at least one full basic irrigation unit (2 ha) on each soil type with local farmers and their normal equipment)	MoWE, BoARD, ARARI
Inadequate skills for practical in-field soil & water management	(i) include precise land levelling in capital costs, (ii) intensive farmer knowledge and skills development by research-backed extension agents, farmer field schools (FFS), etc., (iii) facilitation of access to improved equipment (e.g. broadbed makers)	MoWE, BoARD, ARARI, PSP contractor
Secondary salinisation of soils	In addition to above measures, (i) payment for water on a volumetric basis, not by area, (ii) strict enforcement of drain maintenance both on and off-farm, (iii) close monitoring of (a) groundwater levels and (b) drainage and groundwater salinity	MoWE, BoARD, ARARI, MoWE, PSP contractor, WUAs
Erosion & sedimentation	In addition to above measures (i) effective drainage channel maintenance, (ii) maintenance of vegetation and promotion of vetiver, (iii) consider extension of watershed management projects[4] to Dirma and Nededit catchments	MoWE, BoARD, ARARI, PSP contractor, WUAs
Continuing impacts from floods	(i) develop flood management plans for adoption by IWUAs	MoWE, Woreda, PSP contractor
Inadequate pest management and improper use of pesticides	(i) develop an IPM programme (through a Phase 2 PMP design exercise) and implement it (including beekeeping component), (ii) adult literacy classes, (iii) close monitoring of pesticide knowledge, attitudes and practice (KAP)	BoARD, PSP contractor, ANRS BoE
Agricultural impacts on water quality	(i) consider promoting sustainable/ conservation/ organic agriculture, (ii) promote integrated pest management (IPM), (iii) channel drainage water from fields through wetlands	PSPcontractor, BoARD
Ongoing impacts on globally important fishes and birds	Fish: (i) seasonal research, (ii) support for kebele fishery management programme, (iii) aquaculture trial in command area, (iv) environmental awareness campaign, and (v) contribution to of a lake-wide fisheries management programme	BoARD, BDU, AAU, PSP contractor
	Birds: (i) seasonal bird counts, (ii) conservation of wetland habitats, (iii) lakeshore conservation and restoration programme, (iv) accession to Ramsar Convention, (v) environmental awareness	BoEPLAU, EWNHS, EPA, Woreda, lakeshore Kebeles
Cultural constraints to social and economic change	(i) adult literacy classes, (ii) education to higher grades, (iii) electrification, (iv) all-weather road access, (v) economic betterment (objective of project)	BoE, EEPCo, Woreda, PSP contractor

[4] E.g. TBIWRDP, SLMP.

Potential Impact	Key Mitigation Measures	Responsibility
Impacts on women	(i) construction and maintenance of safe domestic water supply points close to housing, (ii) promotion of homestead fuelwood supplies, (iii) rural electrification, (iv) careful access and child safety planning if settlements are developed and reorganised for irrigation, (v) incorporation of women's quota or other mechanism to ensure participation in WUA decision-making, (vi) provision of micro-credit / income generation programmes for women, (vii) adult literacy classes for women, (viii) upgrading of insttituional capacity to support women, (ix) upgrading of health services (see below)	MoWE, BoH, BoE, EEPCo, Woreda, PSP contractor
Impacts of transformation of livestock husbandry system	(i) inclusion of practical, implementable progamme to reduce livestock numbers in the command area whilst maintaining household incomes and the availability of draught animals in the project, (ii) use land between flood control bunds as pasture, (iii) mechanisation	PSP contractor, ARARI, BoARD
Health issues, especially continuing malaria and an increase in schistosomiasis and helminths	(i) upgrading of health services (health posts) in command area, (ii) improvement of preventive, diagnostic and curative measures in command area for (a) malaria, (b) schistosomiasis, (c) helminths, and (d) other diseases, (iii) management of scheme to reduce vectors, (iv) provision of safe domestic water supplies to all households, (v) sanitation and hygiene campaigns to change behaviour (knowledge, attitude, practice)	MoWE, BoH, PSP contractor, Woreda
Access	(i) include maintenance of the Kola-Diba - Guramba - command area road in the operator's contract	MoWE, PSP contractor
Rduced project benefits due to ineffective provision of essential agricultural services and inputs including research, knowledge, credit, crop storage and processing, and links to markets	(i) clarify project management structure to ensure effective delivery of *all* agricultural services and inputs necessary for scheme success, (ii) incorporate service delivery into PSP contractor's contract as a requirement, with commercial incentives	MoWE, BoARD, ARARI, operator
Reduced project benefits due to inadequate provision of essential social services, especially domestic water, health and adult literacy, also road maintenance, electricity and telecommunications	(i) develop a comprehensive plan for sustainable provision of all the non-agricultural services necessary for sustainable socio-economic development of the command area based on agriculture	MoWE, ANRS line agencies, Dembia Woreda, PSP contractor
Unaffordable O&M costs	(i) write off the capital investment, (ii) phase in full O&M cost recovery gradually in relation to accurate assessments of farm profitability	MoWE

Potential Impact	Key Mitigation Measures	Responsibility
Under-funding of costs of compensation and resettlement, agricultural research, extension services & farmer training, equipment, environmental & social measures, etc.	(i) review the overall project concept and implementation plan to ensure that funds are available for *all* measures required for project success, agricultural and non-agricultural	MoWE
Market inelasticity affecting economics of entire project	(i) focus on import substitution and niche export markets	BoARD, PSP contractor
Cumulative effects on quality and volume of water in Lake Tana	Lake water quality: (i) see water quality measures (above), (ii) in long term, improve condition of Dirma and Nededit catchments by applying watershed management measures proven to be successful by the TBIWRDP, SLM and other projects Lake water volume: (i) establish and build the capacity of the responsible river basin organisation (RBO) - the Abbay Basin Authority, ABA, (ii) establish and use comprehensive water resources management mathematical model of the Lake Tana basin, (iii) transfer control of Lake Tana water levels and management from EEPCo to ABA	MoARD MoWE

Source: Consultant

E6 Monitoring and Management

E6.1 Monitoring

The project will establish both compliance and effects monitoring plans. The compliance monitoring mechanisms will ensure that the various project organisations are implementing the provisions of the ESMP effectively and on time. The effects monitoring mechanisms will check on the impacts which the project is having on the physical, biological and social environment, by regular measuring if indicators. The results will be fed back to project management for evaluation.

In relation to the ESMP, key factors to be monitored relate to the major risks - physical (secondary salinisation), biological (water quality, fish (especially Labeobarbus migration) and birds (use of wetlands), and social (incomes, health, gender issues, and status of vulnerable households).

E6.2 Management

The project's management framework is experimental. On-farm it relies on the establishment of effective IWUAs under new legislation currently in preparation. IWUA creation and operation one of the tasks of the PSP contractor who will also operate and maintain the off-farm infrastructure (pumping station, canals, main drains), and collect fees from the IWUAs on behalf of government. Agricultural and non-agricultural services will be provided by government departments, mainly at woreda level, and the private sector.

This model is high risk; in particular, it lacks a defined mechanism and firm budgets for coordinated delivery of all the many agricultural and non-agricultural services and inputs which are essential for the scheme's success. International experience has demonstrated that irrigation projects without strong, well-resourced and centralised management are unlikely to result in rapid uptake of infrastructure-based economic opportunities, especially in accelerated time scales as envisaged for MPIDP. Consequently it is strongly recommended that consideration be given to creating a unitary authority for scheme management. Logically, this could be done most easily by expanding the role, powers and resources of the PSP contractor.

E7 Costs

Estimated costs for implementation and monitoring of the project's ESMP are summarised in Table E6 and total USD 2.03 M over 8 years. A number of measures have no cost except for management time and therefore are excluded from the table.

The costs of other measures identified in this ESIA as being important for the project's environmental and social success and sustainability are also noted in the table. Some are capital investments (e.g. roads, safe water supplies), others are running costs (e.g. support to WUAs, agronomic research). By far the largest item (USD 3.2 M) is the cost of precise land levelling on 4,040 ha, an item considered by this study to be important for enabling effective soil and water management at farm level on the project area's difficult soils.

Some cost items are outside the scope of this study, but the costs of technical assistance to support prepation of the necessary details have been included. This refers to (i) some public health measures, (ii) livestock husbandry, (iii) mechanisation, (iv) pest management, (v) beekeeping, and (vi) additional community development activities.

Full details are given in Section 8.7 and in the main text.

Table E6: Indicative Costs (USD '000)

Environmental & Social Measures		Other Items	
Pre-construction			
Various measures	40	Land acquisition, compensation etc.	See RAP
		Other measures	165
Sub-total	*40*	*Sub-total*	*165*
Construction (3 yrs)			
Various measures, mainly support for groups, women and adult literacy	382.5	Precise land levelling	3,232
		Upgrade Kola Diba - Guramba track & other roads	345
		Provide safe domestic water	245
		Other measures	528
Sub-total	*382.5*	*Sub-total*	*4,422*
Operation (5 yrs)			
Various measures, mainly support for groups, income generation, women, fisheries, energy and habitat restoration	1,605	Various measures (mainly agricultural)	1,004
Sub-total	*1,605*	*Sub-total*	*1,004*
TOTAL	**2,027.5**	**TOTAL**	**5,591**

Source: Consultant

E8 Conclusions

E8.1 Compliance with Bank Safeguard Policies

Subject to full resourcing and effective implementation of the measures identified in this report, the project is considered to be in compliance with World Bank safeguard policies 4.01 Environmental Assessment, 4.04 Natural Habitats, 4.09 Pest Management, and 4.11 Physical Cultural Resources.

The ESIA study team did not identify any sector of the local population who should be termed "indigenous people" in the sense implied by the Bank's policy 4.10 Indigenous People, and therefore this policy does not apply. Similarly, there are no forests in the area and the project does not involve a dam, so policies OP 4.36 Forests and OP 4.37 Safety of Dams do not apply.

Compliance with the Bank's policy on Involuntary Resettlement (OP 4.12) is the subject of a separate consultancy to prepare a Resettlement Action Plan (RAP) consistent with the Bank's policy and Ethiopian legislation.

Compliance with policy OP 7.50 Projects on International Waterways will be handled by MoWE through Nile Basin consultative processes.

E8.2 Feasibility and Risks

The project is a bold attempt to transform agricultural production methods and yields and at the same time radically change living conditions in a very poor and socially conservative rural society living in a difficult physical location with sensitive ecological values. This approach carries with it a number of risks, economic, institutional, social and biophysical.

Major potential risks of which the project's sponsors should be aware include:

- Ecological: negative impacts on globally threatened fish and migratory birds.
- Physical: groundwater rise and secondary salinisation.
- Economic: market inelasticity.
- Social: slow uptake of benefits due to 'cultural resistance'.
- Organisational: slow uptake of benefits due to inadequate delivery of essential agricultural and non-agricultural inputs and services.

Water availability and climate change are not risks for this particular project.

There is no previous experience of successful implementation of large scale, modern, commercial smallholder irrigation in the Ethiopian highlands, and therefore these risks are significant. At the same time, existing living conditions are unacceptable, the environment is under high stress, and change is imperative.

With respect to the various risks: (i) mitigation and offset measures can mitigate impacts on wildlife; (ii) the technical difficulties of maintaining soil quality will be significant. However, this and other technical challenges concerning soil and water management are likely to be easier to resolve than the social and institutional challenges, especially those relating to land reallocation, reorganisation of settlements, farmer skills and resources for commercial irrigated agriculture, labour availability, on-farm maintenance, service provision and marketing, the service delivery model, impacts on women, impacts on the non-beneficiary population outside the command area, and social change.

E9 Recommendations

The assessment indicates that **two strategic actions** should be taken to help ensure the project's feasibility and enhance its sustainability:

(i) Review the project's framework to confirm that mechanisms and funds have been identified for sustainable delivery of *all* the services and inputs essential for uptake of the economic opportunities created by dry season water availability, including the necessary social investments (safe water, health, literacy, lighting, etc) as well as agricultural services and supplies.

(ii) Recognise the regional nature of some of the impacts and sustainability issues, and initiate responses at this level (specifically: health, wetland protection and recovery, fisheries management, IPM and agrobiodiversity, and cumulative effects).

E10 Next Steps

A checklist of 7 key actions considered necessary in the Pre-Construction Phase is given in Table E7 (for details see the corresponding sections of the impact analysis, Chapter 5 and ESMP, Chapter 8).

Table E7: Recommended Priority Actions

No.	Action	Comment
1	Ensure that the project implementation concept and implementation mechanisms cover *all* the services and inputs necessary for success (agricultural, social, non-irrigation infrastructure) and for the protection of non-beneficiary producers from price shocks (flooded markets).	ENIDP Components 2 and 3 cover some of these actions.
2	Re-visit the concept of full irrigation development within existing settled areas in the light of (i) the impacts and health hazards associated with this activity, and (ii) the possibility of later, phased village reorganisation.	
3	Ensure that the tender documents include comprehensive HSE, labour welfare and social provisions, that the BoQ includes some HSE pay items as incentives, that the HSE enforcement and compliance mechanisms are clear, and that the supervision consultant is resourced and tasked for HSE compliance.	See relevant sections of this ESIA, including the recommendations at Annex 10
4	Establish a formal regional working group chaired by the ANRS BoH to follow up the findings of the Rapid Health Appraisal.	See Annex 7
5	Establish a formal working group chaired by ANRS BoARD to follow up the recommendations of the Phase 1 PMP.	See Annex 8
6	Initiate a regular seasonal bird count in the Dembia Plain, commencing in the dry season 2010-11.	
7	Accelerate establishment and capacity build-up of the ABA Lake Tana sub-office, including the development of firm lake level operating rules which cannot be over-ridden by EEPCo.	

Source: Consultant

1. Introduction

1.1 BACKGROUND

1.1.1 The Study

BRLi (France) in association with Metaferia Consulting Engineers (MCE: Ethiopia) has been awarded a contract by the Ministry of Water and Energy (MoWE, formerly the Ministry of Water Resources (MoWR)) to carry out an Environmental and Social Impact Assessment (ESIA) study of three proposed irrigation and drainage schemes. Two of the schemes are located in the floodplains around Lake Tana (Megech at Seraba, a pumped scheme, and Ribb, dependent on a dam and reservoir); the third is near Nekemte in the valley of the Anger River (Anger scheme, dam and reservoir) (Figure 1-1).

This ESIA report relates to the Megech scheme.

The proposed Megech Pump (Seraba) Irrigation and Drainage Project (MPIDP) is located on the northern side of Lake Tana (Figure 1-2). Some 4,000 ha of low-lying land will be irrigated from the lake by pumping to a main canal and subsequent gravity irrigation. The existing small-holder mixed farming system based on rainfed and flood recession cropping and livestock husbandry will be transformed into a commercially-oriented agricultural system, based on reorganised small-scale family farms.

1.1.2 Study Team

The study was carried out by a team of national and international specialists from BRLi and MCE, as listed in Annex 3.

1.1.3 Project Context

The Nile Basin Initiative (NBI) is a partnership initiated and led by the riparian states of the Nile River through the Council of Ministers of Water Affairs of the Nile Basin states (Nile Council of Ministers, or NILE-COM). The NBI seeks to develop the river in a cooperative manner, share substantial socioeconomic benefits, and promote regional peace and security.

The Eastern Nile Subsidiary Action Programme (ENSAP) is an investment programme under the NBI intended to develop the water resources of the Eastern Nile Basin. It is jointly implemented by Egypt, Ethiopia and Sudan, and managed by the Eastern Nile Technical Regional Office (ENTRO) in Addis Ababa. ENTRO staff identifies and prepares projects, working closely with the NBI Secretariat and NBI National Offices, and the office also provides secretarial support to the Eastern Nile Council of Ministers (ENCOM).

The Eastern Nile riparians - Egypt, Ethiopia and Sudan - have identified promising sub-projects in the areas of integrated water resources management, flood management, power generation and interconnection, watershed management, and irrigation and drainage. To accelerate the progress of project preparation, ENCOM agreed to launch a set of simple and non-controversial 'fast track projects' including, in Ethiopia, irrigation and drainage schemes at Megech and Ribb.

Figure 1-1: Location of Proposed Megech, Ribb and Anger Irrigation and Drainage Projects

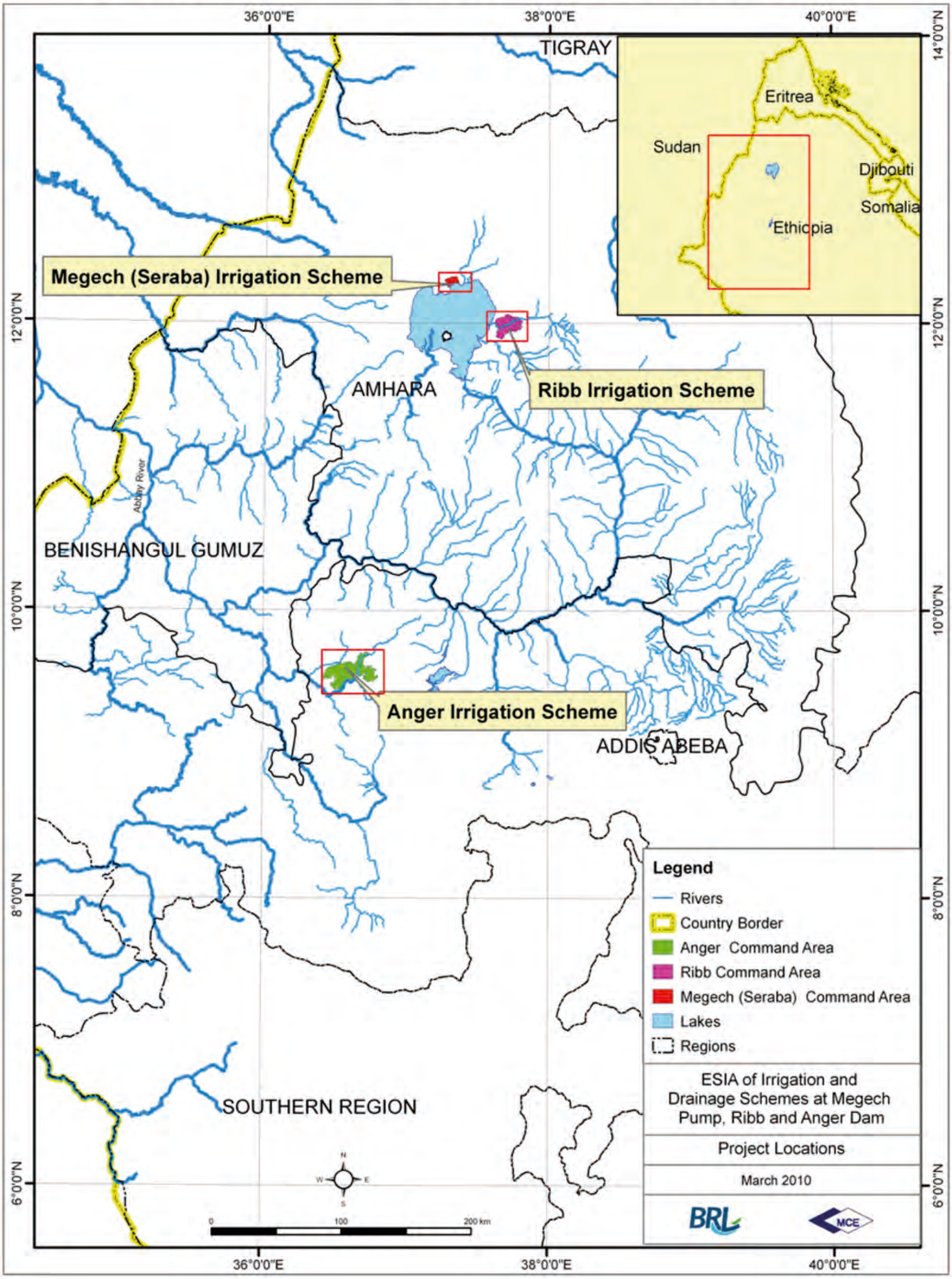
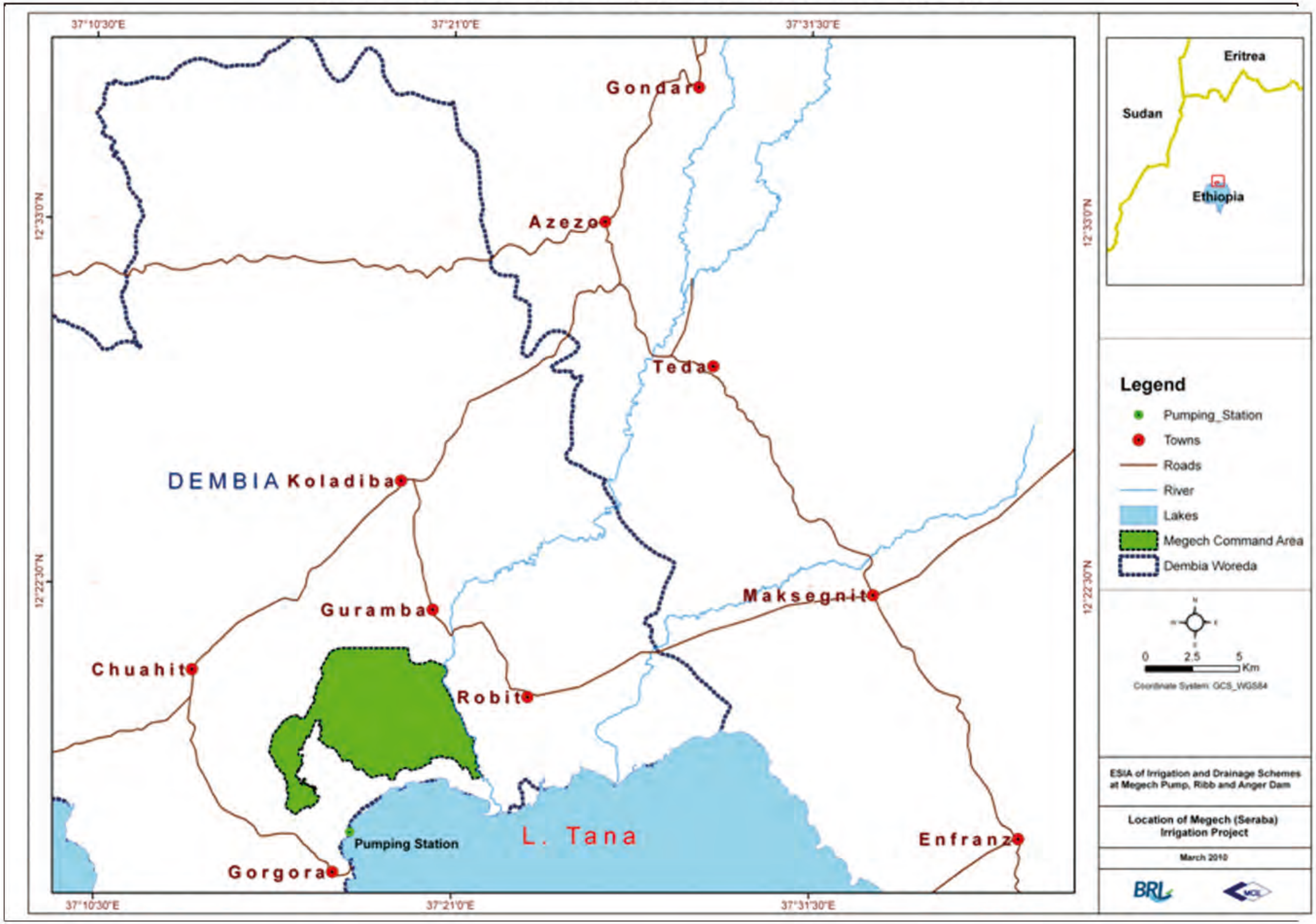


Figure 1-2: Location of Megech Pump (Seraba) Irrigation & Drainage Project



The Megech and Ribb schemes have been incorporated into the World Bank-sponsored Ethiopian Nile Irrigation and Drainage Project (ENIDP). This project will provide funds for the construction of both schemes, together with extensive programmes of further study, support for water users groups, and other aspects of irrigation development and management[5]. The ENIDP also includes funds to ensure that the Megech and Ribb schemes and associated infrastructure such as the Ribb Dam, as well as other proposed hydraulic developments, meet Bank safeguard standards. ENIDP project documentation includes an Environmental and Social Management Framework (ESMF) and a Resettlement Policy Framework (RPF). This ESIA is one of the tasks to be carried out under the ESMF.

Separately, the Government of Ethiopia (GoE) is moving ahead with numerous other water resource development projects around Lake Tana and elsewhere in the Abbay Basin. Some projects have been completed, some are under construction, and some are planned (see Chapter 6, Cumulative and Transboundary Effects).

1.2 Purpose and Status of this ESIA Study

1.2.1 Authorisation of Study

By a contract dated 27 October 2008, the Ministry of Water Resources appointed BRL Ingénierie (BRLi) in association with Metaferia Consulting Engineers as the Consultant to provide Services according to the Terms of Reference for *Consultancy Services Environmental and Social Impact Assessment of about 20,000 ha Irrigation and Drainage Schemes at Megech (Pump) at Seraba), Ribb and Anger Dam*.

1.2.2 Purpose of Study

The objective of the overall assignment is to carry out an environmental and social impact assessment (ESIA) of the proposed Megech Pump (Seraba) Irrigation and Drainage Project, the Ribb Irrigation and Drainage Project, and the Anger Dam and Irrigation Project, and to prepare three separate ESIA reports and environmental management plans (EMPs) for the three projects. The study is intended to meet the requirements of both:

- The Ethiopian environmental regulator (the federal Environmental Protection Authority and/or the regional environmental authorities) for a Schedule 1 project.
- The projects' international sponsor, the World Bank (WB, or "the Bank") for a Category A project. (Note: Bank policy requires that Category A studies are carried out by an independent contractor; see Section 3.5.3.1).

The Terms of Reference (ToR) for the full study (all three schemes) are presented at Annex 11.

1.2.3 Scope of Work

As stated in the ToR (Annex 11), without limiting the scope and content of the final ESIA, the Consultant is generally required to address the following matters:

- Alternate project plans and designs to avoid or minimise adverse impacts, and rationale for the selected alternatives;
- The main environmental effects of the proposed project, both in the project area and in the surrounding area and the timescale of the impacts;
- The size and extent of the impacts based as much as possible on quantitative data rather than qualitative assessment;
- Those groups that will benefit and those disadvantaged by the project;
- The impact on any rare species of plant or animal in the area;
- The impact on human health, and on occupational health and safety;
- The mitigating measures needed and how they should be incorporated into the project design;
- The control and management of the environmental and social aspects of the project to determine if they will be effective;
- Cumulative impacts of the project in combination with similar impacts from other planned or reasonably foreseeable projects or developments in the area; and transboundary impacts;

[5] For details see World Bank, 2007: ENIDP Project Appraisal Document (Report No. 39866-ET).

- The need for further baseline data collection or other specialist studies needed to refine the EMPs proposed in the ESIAs;
- The present policy, institutional and legislative situation and future needs; and
- The monitoring and evaluation activities that are required to ensure that mitigating measures are implemented and future problems are avoided.

Importantly, the ToR state that the EMPs "should contain few, if any, recommended design or operational changes". As made clear during the tender process for this study[6], the intention of this requirement was that changes proposed as a result of the impact assessment should be incorporated into the project design before finalisation of each ESIA and EMP.

It should also be noted that baseline data for the ESIAs was to be provided by the feasibility studies[7].

1.2.4 Purpose and Status of this Report

The Feasibility Study for the Megech scheme was completed in Feb. 2010[8] and the Detailed Design Report in July 2010. The project is now in the final stages of detailed (tender) design[9]. This Environmental and Social Impact Assessment report is the final ESIA Report required under the Consultant's contract and is intended to be the Environmental Assessment (EA) report required by the World Bank prior to formal appraisal of the project.

The report's principal purpose is to give the Client (MoWE) a clear indication of the findings and recommendations of the impact study and thereby (i) to assist the scheme's design consultant (Tahal-CECE) in refining the design of the MPIDP by incorporating various measures to optimise the scheme, minimise its adverse effects, and improve its sustainability, (ii) to alert the Resettlement Action Plan consultant to key issues which will need consideration during finalisation and implementation of the RAP, and (iii) to inform the funding agency (the World Bank) of potential issues so as to assist in optimisation of the overall project design prior to physical implementation.

In relation to project financing, it should be noted that the Ribb Irrigation and Drainage Project (RIDP) will be implemented soon after the MPIDP, and that a separate ESIA report is being prepared for the Ribb project.

1.2.5 Structure of Report

This report has been structured to cover the topics listed in Ethiopia's national and regional EA guidelines and to be consistent with international practice and the ToR. The report contains eight further chapters:

- Chapters 2, 3, and 4 describe, respectively, the proposed project, the policy, legal and administrative framework, and the physical, biological and social setting of the project.
- Chapter 5 is the impact analysis: each potentially significant issue is described, analysed, and evaluated. For simplicity, this chapter also discusses relevant mitigation measures for all predicted adverse impacts. Finally, this chapter identifies enhancement measures where there appear to be significant opportunities for low-cost, high-benefit interventions.
- Chapter 6 discusses the possible cumulative effects of the project when combined with other existing or planned developments around Lake Tana. This chapter also includes an analysis of the project's transboundary impacts.
- Chapter 7 discusses various alternatives to the project as proposed.
- Chapter 8 presents the project's Environmental and Social Management Plan (ESMP), including three sub-plans - Pest Management Plan, Health Action Plan and Physical Cultural Resources Management Plan. The ESMP describes the organisational aspects required for its implementation, together with necessary institutional strengthening and associated costs. In addition, the ESMP covers monitoring and auditing.
- The final chapter presents the study team's conclusions and recommendations, together with a list of next steps to assist decision-makers in implementation of the ESMP.

References and subject-specific bibliographies are provided in a further section of the report.

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6 See Clarifications (#2), 21 March 2008, Section 5, Item 4.

7 See Clarifications (#2), 21 March 2008, Section 5, Item 2, and Annex 1 to the Clarifications, Item 1.

8 An initial Feasibility Study for the MPIDP was completed in May 2009, was revised by Nov. 2009, and further revised by Feb. 2010.

9 The Bid (Tender) Documents in were printed in Nov/Dec 2010.

In addition to this main report (Volume 1), a separate volume of annexes is provided (Volume 2). The annexes include three stand-alone reports:

- Annex 7: Rapid Health Appraisal (covering both the Megech and Ribb projects).
- Annex 8: Phase 1 Pest Management Plan (easily adapted to the Ribb project).
- Annex 9: Reconnaissance Physical Cultural Heritage Survey (covering both the Megech and Ribb projects).

Recommendations for the Tender Documents for both the construction contract and the supervision and O&M contract are given at Annex 10, together with an example checklist of "good housekeeping" for construction sites.

The other Annexes cover, respectively, maps (some at A3 scale), consultation, the ESIA study team, data and documents, ecology, fisheries, the study's Terms of Reference, and (at Annex 12) an outline description of key further tasks, mitigation and enhancement measures identified in the ESMP.

1.3 Approach and Methodology

1.3.1 Overall Approach

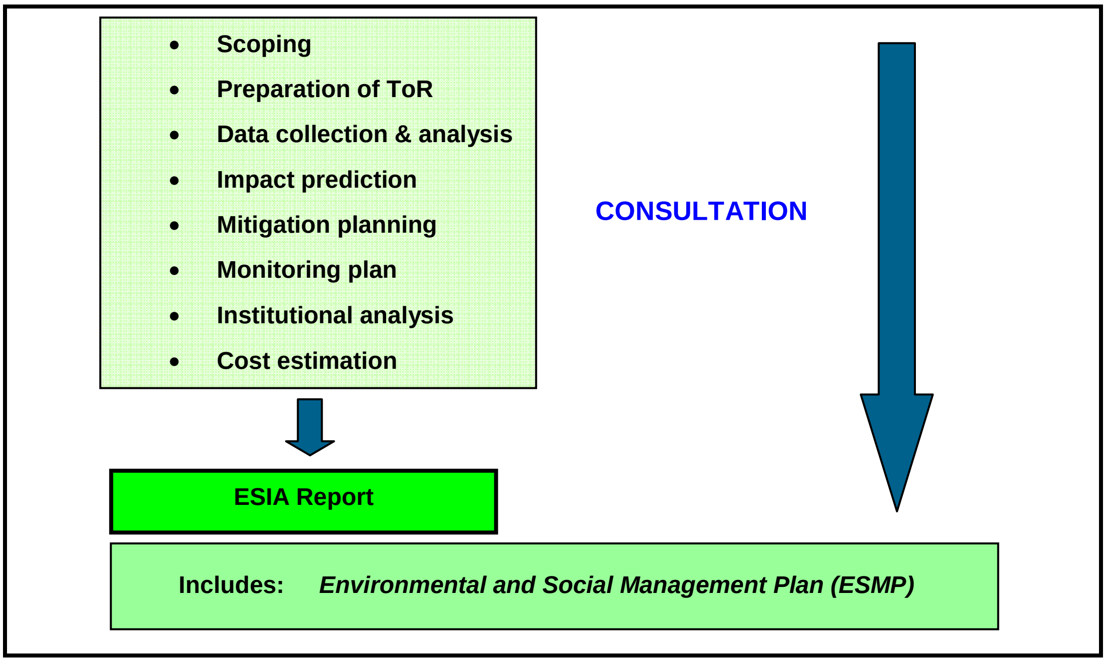
The study team's overall approach to the services was as required by the ToR and reflected in the Consultant's Technical Proposal, specifically a comprehensive ESIA study in accordance with both Ethiopian and World Bank standards.

Impact assessment is a well-established process with standardised terminology and methods. The main steps in all impact assessment exercises are shown in Figure 1-3.

Within this overall framework, key features of the Consultant's approach were (i) use of a multi-disciplinary team of experienced Ethiopian and international professionals, (ii) application of GIS[10] and hydrological modelling techniques, (iii) stakeholder consultations, and (iv) learning from previous experience in Ethiopia, sub-Saharan Africa and elsewhere in the world.

The purpose of the study is to assist GoE and the World Bank in decision-making. This requires that issues are presented in a clear, objective and accurate manner. In formulating this report, the team have been guided by the criteria on 'Presentation of Information' in the Environmental Protection Authority's Review Criteria (EPA 2003) that the Environmental Impact Statement (i) "gives prominence and emphasis to severe adverse impacts, substantial environmental benefits, and controversial issues", and (ii) "adverse impacts are not disguised by euphemisms or platitudes".

Figure 1-3 : Impact Assessment - Standard Steps



Source: Consultant

10 GIS: Geographic Information System

1.3.2 Relevant Guidelines

Ethiopian EPA guidelines and World Bank policies and guidelines applicable to this study are identified in Chapter 3. In addition, many other organisations have published guidelines on impact assessment, on the planning and implementation of irrigation schemes, and on agricultural and rural development. Those used directly in this study are referenced in the text. Some of the most relevant and influential standard works are noted below:

- ILACO. 1981. *Agricultural Compendium for Rural Development in the Tropics and Subtropics.* Elsevier Scientific, Amsterdam. A comprehensive manual still of great value and usefulness.
- WHO-CEMP. 1992. *Environmental and Health Impact Assessment of Development Projects*. World Health Organisation & Centre for Environmental Planning and Management. A standard reference on Health Impact Assessment.
- Mock & Bolton. 1993. *The ICID Environmental Check-List to Identify Environmental Effects of Irrigation, Drainage and Flood Control Projects*. International Commission on Irrigation and Drainage (ICID). A highly practical document listing questions to be asked and data to be gathered when planning I&D and flood control projects.
- Dougherty, T.C. & A.W. Hall. 1995. *Environmental impact assessment of irrigation and drainage projects*. FAO Irrigation & Drainage Paper 53. A straightforward primer on the potential impacts of I&D projects and methods of assessing them.
- WCD. 2000. *Dams and Development - A New Framework for Decision-Making*. World Commission on Dams. A report widely considered to have 'moved the goalposts' by proposing new, more comprehensive and participatory methods for planning and implementing large water resource development projects, based on a 'rights and risks' approach to overcome the significant economic, social and environmental problems associated with many twentieth century water infrastructure schemes.
- Scudder, T. 2005. *The Future of Large Dams: Dealing with Social, Environmental, Institutional and Political Costs.* A critical review by a resettlement expert of the performance of resettlement programmes on many water projects worldwide, with recommendations for new approaches based on higher goals and better planning.
- World Bank. 2005. *Shaping the Future of Water for Agriculture - A Sourcebook for Investment in Agricultural Water Management*. A comprehensive manual on Bank investment in the rural water sector, including guidance on improving rain-fed agriculture as well as irrigation and drainage, and useful discussions of the application of Bank safeguard policies to proposed water investments.

1.3.3 Information Sources

There are many reports on water resources projects around Lake Tana (see list at Annex 4), and a large published literature. These documents are referenced throughout the text, as appropriate. With respect to specific topics, key documents and information are noted below. The approach to specific topics is described in Section 1.3.7, and gaps in knowledge are discussed in Section 1.5, Challenges.

Megech Pump (Seraba) Irrigation & Drainage Project

- 2010: Megech Pump (Seraba) Irrigation & Drainage Project (MPIDP) Detailed Design Report (Tahal-CECE Aug. 2010).
- 2010: Consultancy Services for the preparation of Resettlement Action Plan at Megech (Seraba) Irrigation and Drainage Scheme: Draft Resettlement Action Plan Report (SMEC Aug. 2010).
- 2010: Megech Pump (Seraba) Irrigation & Drainage Project (MPIDP) Feasibility Study, Volume 1 (Main Report) (Tahal-CECE Feb. 2010), 500p. This report includes a chapter on environment entitled Environmental Baseline Study and a social chapter entitled Water Users Association. The other volumes include Annexes and Drawings.

Previous studies of Megech Scheme

- 1964: *Land and water resources of Blue Nile Basin: Ethiopia. Main Report and Appendices I-V* (USBR 1964): a comprehensive first study of the potential for water resources development in the Abbay Basin, identifying many potential dam and irrigation scheme sites.
- 1999: *Abbay River Basin Master Plan - Pre-feasibility Studies - Megech* (BCEOM 1999): this report identified two areas, Megech West and Megech East totalling 11,786 ha, for development by pumped irrigation. The report recommended no livestock development due to the existing livestock feed constraints.

- 2006: *Irrigation and Drainage Projects Identification Study - Final Report* (Tahal-MWH-CECE, July 2006): this report compared 9 proposed I&D projects including Megech Pump as a four-stage development, and recommended fast-track feasibility-level study of Megech Pump (11,786 ha).
- 2007: *Project Appraisal Document* (PAD: World Bank 2007): this provides a full description of the ENIDP including its purpose and objectives, components, organisation and funding.
- 2007: *Environmental and Social Management Framework* (ESMF: ERM 2007): this describes the principal environmental and social issues associated with ENIDP and establishes the procedures and tasks for dealing with these issues during project implementation, including the Megech sub-project.
- 2007: *Resettlement Policy Framework* (RPF: ERM 2007): this describes the approach required for the detailed resettlement planning necessary for each ENIDP sub-project.
- 2007: *Market Assessment Study* (Orgut June 2007). ENIDP: this report reviewed the constraints and opportunities for agricultural product development and marketing and identified two crop groups with market potential.
- 2009: *Operational Action Plan for Commercial Production of Pulses and Other Oilseeds in Ethiopia (Amhara Region): Final Report* (NIRAS Sep. 2009): this report reviews the market potential of various crops that could be grown in the Megech command area and presents action plans for following up the most promising pulse and oilseed options.

Information on MPIDP's sister project, the Megech Pump (Robit) Irrigation and Drainage Project on the Dembia floodplain east of the Megech River is given in:

- 2010: Draft Feasibility Study Report (D3), Megech Pump (Robit) Project, Main Report (Halcrow-GIRD Consultants May 2010).

Additional background on the area is presented in the *Megech Dam Final Feasibility Report* (WWDSE-Tahal 2008), which focuses on the proposed dam on the Megech River and associated gravity irrigation project rather than on the Megech pumped scheme.

The Lake Tana ecosystem

- The best overview is a recent paper by Vijverberg *et al*. (2009) *Lake Tana: Source of the Blue Nile.*

Agriculture in the Lake Tana floodplains

- The Amhara Regional Agricultural Research Institute (ARARI) has recently produced a comprehensive report Agricultural potentials, constraints and opportunities in the Megech and Ribb rivers irrigation project areas in the Lake Tana Basin of Ethiopia (Akalu Teshome et al. 2009).

Social context

- Information on the social make up of the population in the Megech command area is available in (i) BCEOM (1999), (ii) the socioeconomic and resettlement planning volumes of the feasibility studies for the Megech Dam (WWDSE-Tahal 2008), (iii) a report on the potential for a public-private partnership (Castalia Strategic Advisors 2008), especially the detailed survey results in Appendix D[11], and (iv) Tahal-CECE's 2008 socio-economic survey for MPIDP, reported in the Feasibility Study.

  These socio-economic reports are of considerable use as background, although the surveys do not appear to have been designed within the Bank's framework for social assessment, do not use its terminology, and are not consistent in their findings (e.g. very different household incomes are reported by Castalia and Tahal-CECE: see Chapter 4). New information will become available in mid-2010 as a result of the surveys being carried out by the RAP consultant.

Lake Tana - cumulative effects

- For analysing the cumulative effects of the many planned projects on the lake, the most important requirement was digital datasets as inputs for hydrological modelling. Most of the relevant datasets are held by MoWE or its various departments and agencies. Relevant data were obtained and used for our analysis (see Chapter 6).

This ESIA study is an assessment of a proposed project currently in the design process. Consequently the design consultant's reports were a key source of information and data. In addition to the MPIDP Feasibility Study reports, information supplied by the design consultant included digital data (AutoCAD drawings and ArcInfo shapefiles) to assist in the preparation of maps for fieldwork, GIS analyses, and thematic maps.

[11] Castalia Strategic Advisors. 2008 (March). ENIDP - Public-Private Partnership Options and Action Plan Study - Final Report to the World Bank.

Importantly, the design consultant's tasks included a socio-economic survey (mentioned above) and an environmental review, the purpose of which was to provide baseline environmental information for this ESIA. The design consultant's environmental outputs are reported in Chapter E of the MPIDP Feasibility Study report.

Other data sources included (i) other secondary information[12] including internet searches, (ii) interviews with key informants, beneficiaries and other stakeholders, (iii) primary data collection through fieldwork in the project area, especially for fish and social issues (see 1.3.6 and 1.3.7 below).

1.3.4 Scoping

The Ethiopian Nile Irrigation and Drainage Project received extensive environmental and social scrutiny during its preparation phase. As noted above, key outputs from that phase were the Project Appraisal Document (PAD[13]), the Environmental and Social Management Framework (ESMF)[14] and the Resettlement Policy Framework (RPF)[15]. In essence, the work undertaken for the ESMF provided the Scoping necessary to frame the ESIA's ToR and guide the remainder of the ESIA process (this study).

Environmental and social issues that needed to be addressed are listed in several documents, including (i) the ESMF, (ii) the RPF, and (iii) the ToR for this study. These lists and the extensive guidance on the potential impacts of dams and irrigation schemes were reviewed. When combined with the experience of the Consultant's specialists and the findings from the team's initial fieldwork and consultations, the following indicative list of major issues emerged (Table 1-1).

Table 1-1 MPIDP: Indicative List of Environmental and Social Topics requiring Assessment

Topic	Requires Study	Topic	Requires Study
Hydrology		**Socio-economic issues**	
Water supply adequacy	X	Livelihoods, poverty and income	X
Climate change	X	Equity (distribution of benefits)	X
Floods	X	Land take & resettlement	X
Groundwater rise	X	Land redistribution and consolidation	X
Water use efficiency	X	Institutional capacity to manage resettlement	X
Water quality		Gender issues	X
Drainage water quality	X	Minority and vulnerable groups	X
Shallow groundwater quality	X	Cultural heritage	X
Agrochemical runoff	X	Regional effects	X
Wastewater / organic & other pollution	X	Consultation & participation	X
Receiving waters (Lake Tana)	X	Social acceptability & change	X
Soils		Construction camps & related issues	X
Quarries, borrow pits & spoil disposal areas	X	Associated & induced development	X
Fertility & structure	X	**Health**	
Salinity and salinisation	X	Construction health, safety and labour welfare	X
Erosion & sedimentation		Disease ecology (vector habitat)	X
Roads & quarries	X	Introduction of diseases	X

12 Secondary information: information created by others.

13 World Bank. 2007. Project Appraisal Document on a Proposed Credit in the Amount of SDR 65.6 Million (US$100 Million Equivalent) to the Federal Democratic Republic of Ethiopia for an Irrigation and Drainage Project.

14 ERM. 2007. Environmental and Social Management Framework - Ethiopia Irrigation & Drainage Project.

15 ERM. 2007. Resettlement Policy Framework - Ethiopia Irrigation & Drainage Project.

Topic	Requires Study	Topic	Requires Study
Construction issues	X	Water & sanitation at household and community level	X
Catchment management	X	Communicable diseases	X
River morphology	X	Non-communicable diseases	X
Ecology		Nutrition	X
Habitat degradation / reduction	X	Disease prevention and control	X
Threatened / protected species	X	Health service capacity	X
International migratory species	X	**Designs, management & agronomy**	
Protected areas existing / potential	X	Land tenure and consolidation	X
Wetlands	X	Cooperatives and WUAs	X
Natural resource-based livelihoods	X	Institutional capacity & change management	X
Agrobiodiversity	X	Pest and diseases (crops & livestock) & IPM	X
Invasive species	X	Inputs, mechanisation, credit & marketing	X
Cumulative & transboundary effects		Crop storage & processing	X
Lake Tana - hydrology & other users	X	Access and canal crossings	X
Abbay River downstream	X		

Source: Consultant

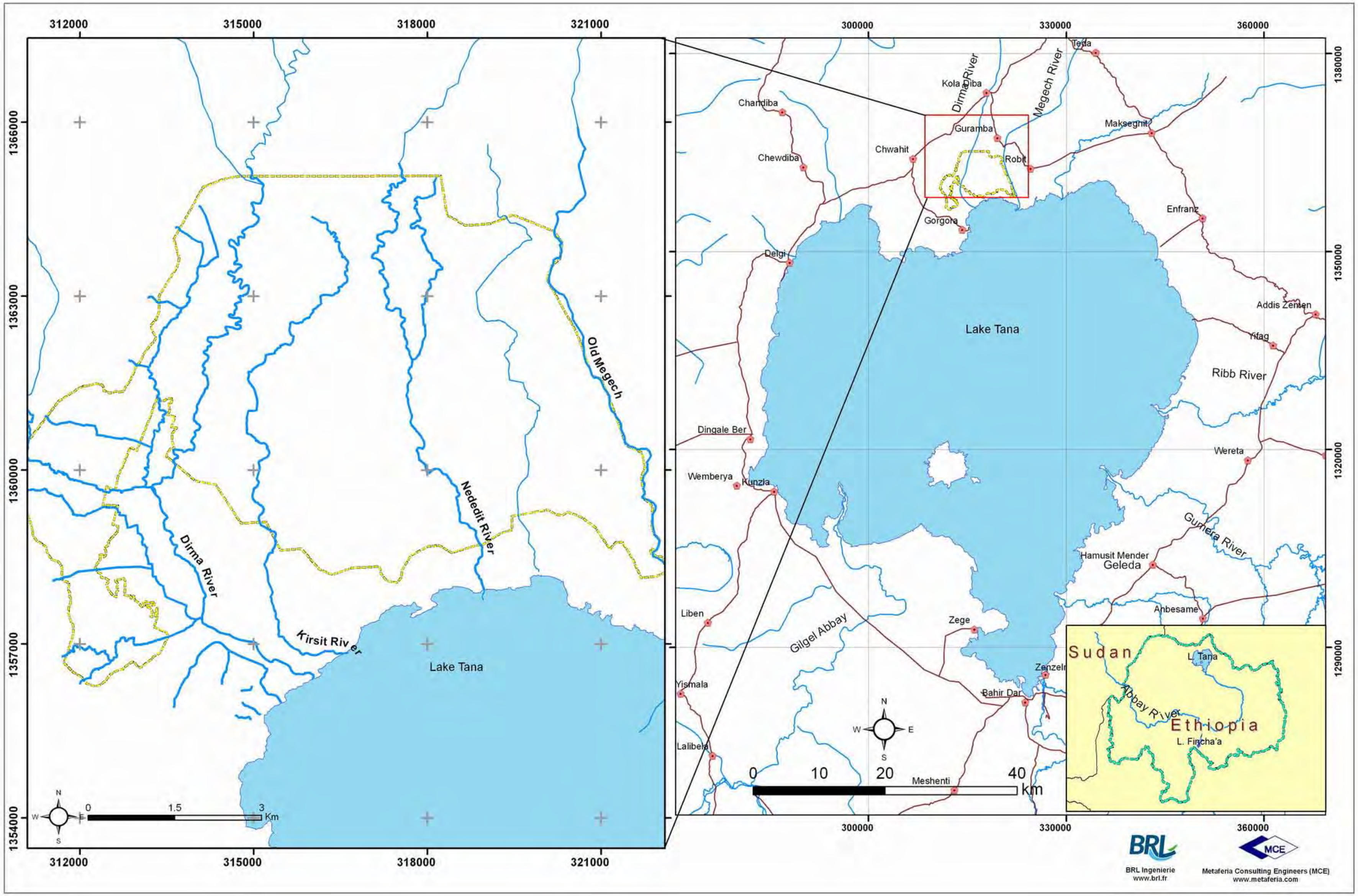
1.3.5 Study Area Boundaries

For the purposes of the impact assessment, different study area boundaries were defined for different purposes:

- For irrigation water management, soils, and drainage: the Project Command Area (PCA) and lakeshore zone.
- For social assessment including health and cultural heritage: the PCA plus the settlements adjacent to the PCA with strong social and economic ties to the people and resources within the PCA.
- For hydrology and watershed management: (i) the catchments of the watercourses crossing the PCA, excluding the Megech River, and (ii) the Lake Tana sub-basin.
- For ecological issues: (i) the PCA and the lakeshore between Gorgora and the Old Megech River mouth ("core study area"), (ii) the overall Dembia plain on both sides of the Megech River, and (iii) all the floodplains and lakeshore wetland surrounding Lake Tana.
- For fisheries issues: (i) the rivers crossing the PCA including the Megech, (ii) Lake Tana and all the rivers entering the lake.
- For transboundary issues: the Abbay Basin as far as the border with Sudan.

These subject-based study areas are illustrated in Figure 1-4.

Figure 1-4: Study Areas



1.3.6 Fieldwork

The study began at the end of November 2008. In December 2008 a preliminary field survey was carried out for familiarisation with the project site and to hold initial meetings with regional and zonal organisations. This was followed by ecological investigation in January and February 2009, including fish sampling. The study was suspended in March 2009 due to non-availability of project design information, and re-started in September 2009. Social, health, soils, engineering and agricultural fieldwork was carried out in October 2009, and a reconnaissance cultural heritage survey was carried out in December 2009. Additional ecological and social fieldwork and consultation on mitigation measures were carried out in February/March 2010 and November/December 2010.

1.3.7 Approach to Specific Topics

1.3.7.1 Terrestrial Ecology

Terrestrial ecological analysis was based on fieldwork focused on (i) characterising and determining the extent of the various remaining semi-natural habitat types in and near the command area (with the aid of GIS mapping and remote sensing); (ii) determining the relative importance of these habitats for threatened species compared to the total area of similar habitat around the lake; and (iii) identifying aspects of the habitats which should be conserved. Because of the focus on wetlands and their values, this work was integrated with the aquatic ecology study described below.

Field surveys were undertaken involving an ecologist and a botanist-taxonomist to determine: (i) habitat types and floral composition of each habitat, (ii) fauna recorded in the study area (in close cooperation with the aquatic ecology survey), and (iii) uses of and threats to wetlands in the area. These surveys were undertaken during the dry season in both 2008-9 and 2009-10.

The following methods were employed:

- Desk study to prepare for fieldwork, including GIS mapping to establish a preliminary delimitation of the different categories of habitat;
- Observations in the field: the fauna and human activities in the study area were observed and recorded, in close cooperation with the aquatic ecology team;
- Listing of vegetation: each category of habitat was investigated at a representative site in order to identify the plant species present and to establish a specific floral composition. When necessary, samples were taken to the laboratory for precise identification. The resulting floral records compiled at 14 representative sites are presented in Annex 5.
- Interviews with local residents in the field concerning fauna, use of natural resources and constraints related to the natural environment.

A key aspect of the desk study phase was compilation of bird records for the area, from a number of sources. The results are attached at Annex 5.3, including observations made by the study team's ecologists during the course of fieldwork.

One significant exercise which may well be of use to other projects and researchers was a thematic mapping analysis using satellite imagery to define wetlands all around Lake Tana (Figure 4-11)[16]. The GIS methods used and resulting map are shown at Annex 1.4, and the area statistics generated reported in Section 4.3.2.

1.3.7.2 Aquatic Ecology

Limited dry-season fieldwork was carried out: (i) at seasonal and permanent wetlands within the command area, (ii) along and at the mouth of the Dirma river, (iii) along the lakeshore, focusing in the pump station site.

[16] The GIS data layers will be submitted to MoWR in digital format as part of study finalisation.

The surveys involved both fish sampling and interviews with key informants, and aimed to: (i) characterise the aquatic ecology of the seasonal and permanent wetlands within the command area; (ii) identify any significant ecological or economic values of the wetlands; (iii) determine the dominant fish species in the area of the pumping station and along the Dirma River; (iv) characterise the ecology of the lake shore in this area, including people-wildlife interactions (hippos); and (v) describe the fishery in the area.

The following methods were employed:

- Observations: the fauna, the wetlands and human activities taking place in the lake and the associated wetlands were observed and recorded in close cooperation with the terrestrial ecology team.

  Sampling: fish were caught using gill nets of various mesh sizes (6, 8, 10 and 12 cm) at six sites in the lake and along the project area rivers. Beach seines and cast nets were also employed (Photo 1-1). GPS coordinates of the sites are given in Annex 6, together with the raw data on species, numbers and maturity stages. The sites were:
  - Lake Tana near the pumping station site
  - Lake Tana at Dirma River mouth
  - Nededit River
  - Dirma River lower reaches ("Doro Mender")
  - Dirma River lower reaches ("Wawa" Farm)
  - Dirma River upper reaches ("Kola Diba")
- Interviews with fishermen using a semi-structured questionnaire.

Photo 1-1: Fish sampling with cast net for ESIA, Dirma River, Feb. 2009

Subsequently the fisheries analysis and mitigation process was coordinated with parallel fisheries initiatives affecting the lake as a whole, largely generated as a result of concern about the impacts on fish and fisheries of the Ribb dam and irrigation and drainage project.

1.3.7.3 Hydrology

Water availability: the Megech scheme is dependent on pumping from Lake Tana and therefore is not subject to supply-side issues, except insofar as the consumptive use of water affects the lake's overall balance, and irrigation drainage water affects the lake's water quality. These issues were considered under "Cumulative Effects" (below).

Water quality: the hydrology sub-team investigated potential water quality issues, focusing on (i) groundwater salinity, (ii) agrochemicals in drainage waters, (iii) potential impacts on surface water quality from inadequate wastewater management, and (iv) household water quality.

Groundwater: the ESMF for the project emphasised the importance of groundwater exploitation as a potential issue. The design consultant's hydrogeological study characterised the shallow groundwater in the command area as of limited suitability for irrigation, specifically due to high or very high salinity and therefore unsuitable for use on areas with restricted drainage[17]. A groundwater investigation of the Lake Tana sub-basin is ongoing under the Tana-Beles Integrated Watershed Resources Development Project.

[17] Tahal-CECE (2009): FS Annex A.4 Hydrogeology.

1.3.7.4 Social Assessment

The proposed project involves significant social as well as physical engineering, and will have major social impacts. Particular concerns are the social distribution of benefits - "who will get what" - the protection of the vulnerable, the treatment of people affected by resettlement to make way for the physical infrastructure, and the creation of sustainable organisations for scheme operation.

Effective social impact assessment requires a detailed understanding of the social context of the project, so that predictions of impact can be made with reasonable certainty and practical mitigation measures developed. In addition, the impact assessment process can become an empowering mechanism for disadvantaged groups in its own right, if sufficiently participatory.

The Feasibility Study provided a useful quantitative basis for the ESIA's social assessment, but a significant level of additional social investigation was required to obtain information on key questions such as (i) how can the existing land tenure system be reorganised equitably to enable intensive irrigated agriculture, (ii) who will be the beneficiaries?, (iii) who might lose - or rather, how can all persons affected by the project gain benefits from it ('no losers')?, (iv) if two or even three crops are already grown, what benefits would irrigation actually bring?, (v) is the population ready to organise into WUAs with their associated powers to raise fees and sanction transgressors?, (vi) what input systems (credit, seeds, machinery, fertilizer etc) are needed for more intensive agriculture?, (vii) what crop processing and storage facilities will be required?, (viii) what marketing systems and infrastructure will be required?, (ix) how could the role of livestock and the income of livestock owners be maintained during and after the transition to irrigation?, (x) what services will need to be upgraded to optimise development benefits (health, education, electricity etc)? (xi) what is the institutional framework and do the various organisations have the capacity to manage and react to rapid change?

Tools used were focus group discussions and key informant meetings with semi-structured interviews (Photo 1-2; for locations of sites visited see Annex 1, Map 6; for names and locations of focus groups and case studies see Annex 2).

Photo 1-2: Typical farmers' and women's focus group meetings in command area for ESIA, March 2010

All social investigation work has been integrated with the parallel ecological, heritage and health investigations.

The lessons of recent irrigation projects with significant challenges, such as Koga, are incorporated in the assessment, based on both reviews of Koga-related documents and site visits.

1.3.7.5 Cultural Heritage

Available reports and initial investigations indicate that all recent (historical) physical cultural heritage sites ("cultural property") around Lake Tana are (i) well known, and therefore easy to avoid by adjusting project layouts, and (ii) on higher ground, and therefore not subject to impacts from waterlogging. These sites include, most importantly, churches and cemeteries.

In contrast, very little is known about the prehistoric heritage of the area. Most archaeological attention has been paid to sites at lower elevations in Ethiopia, resulting in spectacular discoveries such as that of Lucy, our hominid ancestor. The few published papers suggest a possible rich legacy of both faunal remains (especially Oligocene mammals and palaeobotany) and human artefacts (especially Acheulean hand tools) in the Lake Tana area. One of the known sites is a rock shelter at Gorgora, described by L.B.S. Leakey in 1943; others are at Gonder and Chilga Kernet (west of Gonder).

In view of this potential, contact was made with specialists at Addis Ababa University (AAU) and with international scientists involved in the Blue Nile Basin Survey Project, a long-term archaeological/palaeontological investigation at present focusing on the region west of Gonder. Discussions with these scientists indicated the probability of the existence of unrecorded archaeological sites in the Gorgora-Seraba area.

Under these circumstances, and in accordance with the guidance in the relevant Bank documentation including the new Guidebook[18], a reconnaissance physical cultural heritage survey was carried out in December 2009 in preparation for possible development of a Physical Cultural Resources Management Plan (Annex 9).

The objectives of the survey were to:

- Characterise the physical cultural resources of the areas of the Megech/Seraba and Ribb irrigation and drainage projects;
- Undertake a walkover of selected areas to investigate their cultural significance from visible cultural remains, as an input to predicting possible impacts, and
- Identify further actions required to fill information gaps and mitigate potential significant impacts, if any.

Methods and techniques adopted included:

- Review of literature dealing with the regional history of the project areas;
- Review of relevant Ethiopian environmental and cultural legislation;
- Visit to the project areas to contact relevant government authorities, the region’s project implementation teams, and key informants such as local representatives (elders), and religious leaders (clergy);
- An initial walk-over site survey of key locations to locate cultural centres and record important localities with GPS and camera.

The survey party consisted of (i) an Ethiopian cultural heritage specialist (a lecturer in archaeology and cultural heritage management from AAU), and (ii) a French rural sociologist (the ESIA team's lead sociologist), and was accompanied to most sites by staff from the local administrations as well as local residents. The survey's itinerary and a list of persons consulted is attached in Annex 9.

The findings of the survey were discussed with the responsible government institution - the Authority for Research and Conservation of Cultural Heritage (ARCCH) - which resulted in the Authority proposing their own official follow-up survey to confirm the ESIA team's preliminary findings and act as the basis for further measures (see Annex 12.2).

1.3.7.6 Health

The project's ESMF and the ToR both emphasise the risks to human health of the proposed project, with a focus on water-related diseases, and especially malaria and schistosomiasis. Initial fieldwork confirmed the existence of these health hazards and others in the project area.

Given the importance of this aspect of the study, staffing was adjusted so as to upgrade the resources available for health impact assessment. This allowed the implementation of a rapid health appraisal[19] of the project involving (i) identification of health hazards, (ii) assessment of the potential health impacts of project construction and operation on local residents and other at-risk groups such as construction workers (community vulnerability), and (iii) initiation of planning for appropriate health system responses (Annex 7).

1.3.7.7 Soil & Water Engineering

The study team included specialists in both soil science and irrigation engineering. These specialists reviewed the technical aspects of the proposed design to ensure that critical aspects such as soil salinity, drainage effectiveness and in-field erosion were not overlooked. In addition, the soil scientist contributed to the team's understanding of erosion processes and in-field soil management.

[18] WB. 2009. Physical Cultural Resources Safeguard Policy Guidebook. World Bank, Washington, DC.

[19] See p4 of World Bank 1997 - EA Sourcebook Update 18 - Health Aspects of Environmental Assessment; also see IFC (2009): Introduction to Health Impact Assessment.

1.3.7.8 Agronomy and Pest Management

The study team included an agronomist. This specialist reviewed the agronomic aspects of the project to identify probable changes in pest and disease burdens and likely responses such as the use of pesticides, and contributed to development of a Phase 1 Pest Management Plan (Annex 8).

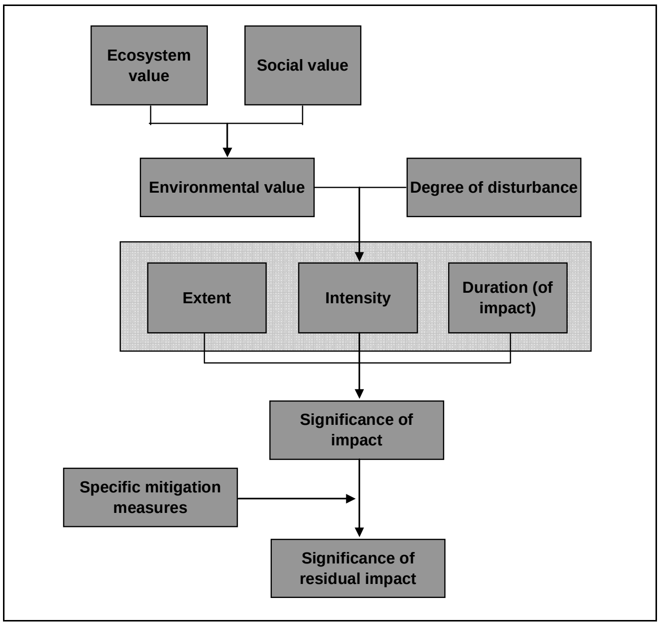
1.3.8 Impact Identification and Mitigation

This task involved the identification and quantification of potential social and environmental impacts, followed by an evaluation of their significance and then the development of practical mitigation measures for any impacts found to be both significant and negative (see Chapter 5).

The process of impact identification and evaluation was carried out by the team specialists, focusing on the issues noted under scoping, and covering both direct and indirect or induced effects at all project stages. The process is illustrated in Figure 1-5.

The development of mitigation measures was carried out in cooperation with the design consultant and in discussion with primary stakeholders, in particular the project beneficiaries, other interested and affected parties, and the institutions / organisations which will be responsible for implementation of the measures (e.g. the ANRS Bureau of Health).

Figure 1-5 : Standard Flowchart for a Systematic Approach to Impact Assessment



1.3.9 Cumulative Effects

The Government of Ethiopia is moving ahead very rapidly with numerous large hydraulic infrastructure schemes in the Lake Tana basin (see Table 6-1 in Chapter 6). The intention of these schemes is to accelerate economic development by providing electricity from hydropower and water for irrigation from storage dams. There is considerable concern that this objective will not be reached without significant adverse consequences, for example on lake navigation, on the ecological values of the wetlands surrounding the lake, and on the tourism value of the Tis Issat Falls. There is also concern that the pace of physical change may run ahead of the necessary policy and institutional development, such as the need to establish effective irrigation scheme management and operation organisations, Water Users' Associations, and a River Basin Organisation to regulate water management.

The potential cumulative effects of the MPIDP and other projects on Lake Tana were assessed by hydrological modelling using the MIKE BASIN hydraulic model developed by SMEC[20]. In addition, other decision support systems for water management in the lake were reviewed, including that developed by McCartney *et al*. (2008)[21].

20 SMEC. 2008. Hydrological Study of the Tana-Beles Sub-basins - Main Report.

21 McCartney, M. *et al*. 2008. Estimating Environmental Flow Requirements downstream of the Chara Chara weir on the Blue Nile river. IWMI.

1.3.10 Transboundary Effects

The likely effect of the project on the hydrology of the Abbay River at the border with the Sudan was reviewed, based on outputs of the modelling developed for the cumulative effects assessment.

1.3.11 Alternatives

The MPIDP design consultant was required to consider alternate project designs to minimise environmental impacts. This work, which focused on soil quality and land drainage, formed the basis of our own review of alternatives (design, layout, operation and management systems: see Chapter 7). The review also includes a discussion of the 'without project' or 'no action' alternative.

1.3.12 ESMP

The ToR provide a straightforward breakdown of the aspects to be covered in the MPIDP's EMP:

- Summary of impacts
- Description of the specific mitigation measures
- Description of monitoring programmes
- Reporting and review procedures
- Institutional arrangements
- Capacity building requirements
- Cost estimates and sources of funds

Considering the importance of social issues on this project, and to be consistent with international practice, the EMP has been prepared as an Environmental and Social Management (ESMP). The recommended contents of an ESMP for a Category A project are given in Box 1-1.

Box 1-1: Recommended Contents of ESMP for Category A Project

Social and Environmental Management Plan: a systematic description of the mitigation and/or sustainable development measures to be taken during project construction and operation to avoid, minimise or compensate for significant adverse impacts and enhance project benefits, plus actions to be taken to implement the measures. The Plan will cover:

- *Impact summary*: summary of significant negative and positive impacts
- *Mitigation and development measures*: description of each mitigation and/or development measure including to which predicted impact(s) it relates how and where it will be applied - including any *Resettlement Action Plan* needed for persons affected by the project, developed with their participation
- *Timing*: an implementation schedule for each measure linked to the overall project timeline
- *Monitoring and reporting procedures*: the mechanisms for compliance and effects monitoring, including indicators, methods and timing and feedback to management and stakeholders
- *Responsibilities*: assignment of responsibilities for implementation, coordination, supervision, monitoring and QA/QC, enforcement, reporting, financing and staff training
- *Institutional strengthening requirements*: description of any organizational changes and institutional strengthening required to implement the Plan
- *Costs and budgets*: cost estimates and initial and recurrent budgets for all measures, integrated into the total project investment and operational cost tables

Source: adapted from World Bank Operational Policy 4.01 Environmental Assessment (1999) and IFC Good Practice Note 3 Addressing the Social Dimensions of Private Sector Projects (2003)

The final format and content of the ESMP also reflect the guidance available on EMPs from the regional environmental authority[22] and the EPA. It contains two major sub-plans:

- Phase 1 Pest Management Plan
- Resettlement Action Plan (prepared and presented separately)[23].

[22] Amhara: EPLAUA, 2006 - Simplified General EIA Guideline.
[23] A draft RAP became available in Aug. 2010 and the final version is in preparation (SMEC 2010).

Further sub-plans, such as a Physical Cultural Resources Management Plan or Health Action Plan, could be incorporated in the ESMP at a later stage if the relevant authorities find such plans to be appropriate.

1.4 CONSULTATION

1.4.1 Public Consultation and Disclosure

Informing and consulting the public are integral tasks within the Environmental Assessment process in Ethiopia, are required by the World Bank, and form part of best practice. Accordingly, the ToR required the ESIA Consultant to organise and implement a public consultation programme in undertaking the ESIA, in collaboration with MoWE and the regional authorities implementing the ENIDP. The programme was to encompass: a) informing stakeholders about the proposed ENIDP investments, and soliciting their concerns; b) involving stakeholders in further refining the definition of issues to be addressed in the ESIA, of what adverse impacts might be created, and of what mitigation approaches and measures might thus be appropriate; and c) soliciting comments on the draft final ESIA report. The Consultant's proposed workplan for this programme was not funded.

To meet the requirements of both the national and regional regulatory authorities and the World Bank, an alternative consultation programme has been implemented by the ESIA team including:

- **Stage 1: Stakeholder Analysis**

  Stakeholder analysis involved several steps, in order: (i) stakeholder identification, (ii) initial consultation, (iii) analysis of stakeholders' interests and capacities, including relative importance, degree of influence, social capital[24] and experience with participation, and (iv) development of a framework for further consultation with and participation by these stakeholders in accordance with their capacity and relevance to each issue.

- **Stage II: Stakeholder Involvement**

  During this stage stakeholders were consulted (i) with respect to the significance of impacts, and (ii) to assist in formulating mitigation measures. This stage was extremely important since it ensured, through stakeholder internalisation ('buy-in'), that the mitigation measures (a) will be acceptable to the organisations responsible for funding and applying them, and (b) will be practical, and therefore will actually be implemented.

  Mechanisms for this process varied from straightforward discussions with specialists and decision-makers in concerned organisations to meetings with local administrations and focus group discussions with project beneficiaries.

In carrying out this programme the Consultant:

- Coordinated as far as possible with the consultation and awareness activities of the design consultant, who arranged a local workshop to introduce and discuss the scheme.
- Maximised the use of the study team's specialists, especially the social scientists, to raise awareness of the project amongst beneficiaries and other affected groups and to obtain feedback on local issues.

1.4.2 Stakeholder Identification and Analysis

The initial stakeholder identification exercise identified a wide range of primary and secondary stakeholders. These have been grouped into categories (Table 1-2) and analysed in terms of features, interests, influence etc. (Table 1-3).

1.4.3 Stakeholder Consultation and Concerns

Substantive discussions have been held with the primary stakeholders, some of the secondary stakeholders and project beneficiaries, and contact made with the environmental regulators. A list of persons and organisations contacted by the ESIA study team is included at Annex 2.

Some stakeholder concerns are identified in Table 1-2 and Table 1-3 below. The over-riding concern of local residents is access to land for cultivation because this is seen as fundamental to personal and household food security and livelihoods. As stated in the Feasibility Study (Tahal-CECE 2010):

[24] For explanation of terms, see (for example): AsDB. 2007. Handbook on Social Analysis - A Working Document.

"Eviction from their farm lands in order to hand them over to private commercial investors, obtaining low fertility land due to land consolidation, loss of grazing lands for their livestock, and lack of demand for the mass produced farm outputs are the main concerns and threats to the farmers."

Stakeholder concerns are reported throughout the text, and have been incorporated into the impact analysis and mitigation measures.

Table 1-2: Initial Stakeholder Identification

Primary Stakeholders
Project proponent and international sponsor (MoWE, WB), plus MoARD
Project beneficiaries (farmers and their families, in command area)
Other project area residents, including (i) those potentially advantaged by employment opportunities, and (ii) those potentially disadvantaged such as (a) people affected by resettlement, land redistribution, restrictions on land use or restrictions on resource access, (b) the landless, (c) people outside the command area but depending on resources within it, especially dry-season grazing, (d) rain-fed producers in nearby areas potentially exposed to price reductions
The ANRS Regional Government and its various departments (especially water, agriculture and rural development, environment, land administration, health, women's and children's affairs, culture, tourism & parks development, cooperative promotion and economic development), the Regional Project Steering Committee (RPSC) and Regional Project Coordination Office (RPCO), together with the zonal equivalents in North Gonder Zone
Dembia Woreda administration, Woreda Project Implementation Team (WPIT)
Kebele administrations: Aberjeha Dhena, Achera Mariam, Chenker Cherkose, Guramba Bata, Jangua Mariam, and Seraba Dabelo
Project builder and project operator (private sector)
Cooperatives and Peasants Associations (36 in Dembia Woreda) and traditional WUAs (*Yewuha abat*)
Secondary Stakeholders
Lake Tana users - navigation, fishers, tourism, including private sector (e.g. FPME)
Downstream water users in the Abbay Basin
Environmental, social and cultural NGOs: ORDA, EWNHS, EWNRA, Ethiopian Orthodox Church
Academia, including government research scientists: principally ARARI, BDU, BFALRC, also AAU
Supply and services organisations: AISCO, Ambasel, Tsehay Cooperative Union, ACSI
Other concerned federal ministries and agencies - Ministry of Culture and Tourism, EPA (in addition to MoWE, MoARD)

Source: Consultant

Table 1-3: Stakeholder Analysis

Stakeholders	Main Features / Characteristics	Views / Interests	Worries / Fears	Experience in Irrigation / PPP	Power / Influence
GOVERNMENT					
National level	*Key stakeholders:* MoWE / MoARD	Want to alleviate poverty in Ethiopia (PASDEP) & improve food security. Want to transfer some risks to private sector (for O&M).	Willing to subsidise capital costs but not O&M. Concerned about finding an effective delivery model.	Previously in Awash Valley in the '70s and '80s. Koka scheme in Abbay basin.	Driving force behind project. Principal strategic decision-makers. Arrange project financing. Supervise PPP.
Regional level	ANRS BoWRD ANRS BoARD RPSC / RPCO BoH	Want to help farmers within Amhara access irrigation water and services. Concern about public health.	Social resistance Budget constraints Low capacity	Limited (since Koga project just beginning operate).	Mandate for managing large/medium schemes. Power relatively weak because of lack of regional autonomy and funds. BoH can play 'health card' to influence decision-making.
Woreda level	Dembia Woreda Water Resources Dept. & ARD Dept. WPIT	Want to raise living standards of rural population & develop social infrastructure within the *woreda* (health, education etc.).	Social resistance Budget constraints Low capacity	Small-scale only.	Many responsibilities concerning project implementation, but staff, skills and budgets stretched thin. Receive funds from National levels.
PRIVATE OPERATORS					
	International construction & agribusiness companies contracted through international bidding	Want to profit at low risk. Interested in any potentially profitable activity - construction, O&M, supply of goods & services, marketing.	Do not want to be exposed to financial risk, and want certitude concerning recovery of any investment. Concerned about experimental partnership model.	International experience in irrigation, drainage, agribusiness.	Corporate connections and networks. Relatively low influence on smallholders. Importance will grow with successful O&M and service delivery, and especially if land becomes leased or commercialised.

Stakeholders	Main Features / Characteristics	Views / Interests	Worries / Fears	Experience in Irrigation / PPP	Power / Influence
FARMERS WITH LAND OR GRAZING INSIDE THE PCA					
Average households	About 24,000 people. Average total annual household income ETB 1,166/yr, ~ per capita ETB 194/yr.[1] Population density: ~2 pers/ha[2]	Want to benefit from the project, learn new techniques, get more access to farming inputs and markets, generate higher incomes.	Concerned that land re-allocation process will not be equitable, that WUAs may not be efficient, that market access may be insufficient, and that livestock grazing and numbers will be reduced too much.	10 to 15% of PCA farmers practice traditional irrigation (hand-made earth dams for river diversion, small water pumps).	Almost no financial or judicial power. Low educational level. Highly exposed to social and environmental risks.
Vulnerable households	Around 20% of the PCA population, including the elderly, widowed women and people without land.	Want to benefit from the project through increased economic and social security and opportunities for improvement.	Concerned at possible disruption of existing housing, support mechanisms, becoming even more vulnerable, poor, and marginalised.	None.	No financial or judicial power. Very low educational level. Extreme exposure to social and environmental risks.
FARMERS OUTSIDE THE PCA					
	Total population of Dembia Woreda is around 270,000 people. Pop. Density: 2.23 pers/ha	Want to see benefits spread outside the command area and avoid impacts on price of produce.	Price reductions for rain-fed produce, exclusion from markets.	One cooperative specialised in irrigation for whole woreda.	Almost no financial or judicial power. Low educational level. Highly exposed to social and environmental risks.
EXISTING COOPERATIVES					
	In Dembia Woreda: 36 cooperatives, of which 29 are multipurpose and 1 dedicated to irrigation	Want to attract more members, so that increase in capital from contributions allows development of the association.	Concerned that WUAs will replace cooperatives.	Some experience in collecting fees for traditional irrigation, canal maintenance, provision of inputs.	Constrained by relatively low membership, limited capital, and negative perception of public regarding cooperatives.

1. Income data from Feasibility Study. 2. Population data from draft RAP.

Source: Consultant; info. on cooperatives from Akalu Teshome e al. 2009

1.5 Challenges

The study has faced a number of challenges and constraints. Those which have had a significant effect on smooth implementation of the assessment process and on the quality of the analysis and outputs are noted below.

1.5.1 Delays

The purpose of this ESIA study is to determine the potential effects of the proposed irrigation and drainage scheme, to mitigate any significant negative effects, and to ensure the project's sustainability. This requires full information on the design and layout of the scheme and on other key features such as service delivery and management mechanisms. The minimum standard of information required for effective assessment is feasibility level. The ESIA study commenced at the beginning of November 2008 but had to be suspended in early 2009 since the Megech feasibility study was not received until May 2009. Subsequently the ESIA team was re-mobilised, but the Consultant then learned that the feasibility study was under revision, with new versions becoming available in both November 2009 and February 2010.

The delays and re-mobilisation affected resource use and staff availability, creating additional costs, diverting management attention from technical tasks, and necessitating some substitution of personnel.

1.5.2 Lack of Data - Information Gaps and Uncertainties

1.5.2.1 Gaps and Weaknesses in Baseline Data

In planning the study, the ESIA Consultant understood that comprehensive data on environmental and social topics would be available from other sources[25], and that there would be little or no need for primary data collection. In the event, data gaps were found to exist with respect to (i) some social and livelihoods issues, for example social capital and the economic and social linkages between the command area and residents of the surrounding hills, (ii) health, (iii) cultural heritage, and (iv) both terrestrial and aquatic ecology (principally birds, fish, and wetland-resource livelihoods). Primary data collection by the ESIA team filled the gaps sufficiently for preparation of this impact assessment. For some topics (e.g. epidemiology) very specialised surveys will be required for effective management and monitoring and are recommended in Chapter 8, ESMP and the supporting report (see Annex 7, Rapid Health Appraisal)[26].

1.5.2.2 Gaps in Information on Proposed Project Organisation & Implementation

As noted above, the project is a bold attempt to transform agricultural production and livelihoods through physical and social engineering. However, details of how some of the many services and inputs required for scheme success will be provided and managed remain unclear - see Sections 5.4.10.3 and 5.4.10.4. Again, recommendations on key issues are given in the ESMP.

1.5.3 Seasonality and Access

Data collection for some of the topics in the assessment is seasonally-dependent, for example fish spawning at the height of the rainy season, cattle movements between the command area and the hills at the beginning and end of the rains, and migratory bird counts between arrival and departure dates; ground-based surveys such as archaeological walk-overs need to be carried out during the dry season when vegetation has been grazed, as should social surveys which require household sampling across the command area. Most of the command area is inaccessible by land for much of the year (June to October) due to flooding. The road from Dembia Woreda headquarters (Kola Diba) to Guramba and then to the command area was cut by a gully for most of 2009. These constraints are not easily resolved within time-bound impact studies.

[25] The design consultant's environmental task was to be "devoted to the intensive collection of comprehensive quantitative and qualitative data, followed by their organization and analysis in a format that will permit preparation of the EIA report by a different consultant" (Tahal-CECE Inception Report, March 2008).

[26] In accordance with the ToR requirement to address "the need for further baseline data collection or other specialist studies needed to refine the EMP(s) proposed in the ESIA".

2. Project Description

2.1 Introduction

In this chapter we describe the proposed project. The basis of the description is the *Megech Pump (Seraba) Irrigation and Drainage Project Feasibility Study Report* (Tahal-CECE, February 2010) with some updating from the *Detailed Design Report* (July 2010). Where necessary we have added information from other sources including draft documents concerning the project concept, operation and management, and marketing.

It should be noted that the MPIDP Feasibility Study presents three options for scheme development. Options I and II combine surface (gravity) irrigation with pressurised irrigation. Option III is for surface irrigation only, and has been selected by MoWE. Therefore this description focuses on Option III. Options I and II are discussed in Chapter 7, Alternatives.

2.2 Key Parties in the EA Process

Table 2-1 lists the key parties relevant to the project, in terms of the roles and responsibilities in the EA process as defined in the EPA's EIA Procedural Guideline Series 1 (EPA, 2003) (see Table 3-1 in Chapter 3 for definitions of parties).

Table 2-1: Key Parties Relevant to the EA Process for MPIDP

Role	Organisation	Contact Details
Proponent	Ministry of Water Resources	Ato Hayalsew Yilma National Project Coordinator Ministry of Water and Energy P.O. Box 5744 Haile G/silase Street, Addis Abeba Tel: 011 663 8506
Consulting Firm	BRL Ingénierie (France) in association with Metaferia Consulting Engineers (Ethiopia)	Dr. Gilles Pahin Project Director BRL Ingénierie 1105, avenue Pierre Mendès-France BP 4001 30001 Nîmes Cedex 5, France Tel: +33 4 66 87 51 99
Environmental Agency	(i) Environmental Protection Authority (EPA)	Dr. Tewolde Birhan Gebre Egziabhere PO Box 12760, Addis Ababa 011 646 5007 / 4604 / 4898
	(ii) ANRS Bureau of Environmental Protection, Land Administration and Use (BoEPLAU)	Ato Kebede Yima Dawud PO Box 145, Bahir Dar 058 226 5475 / 5478
Interested and Affected Parties (IAPs)	See Stakeholder Analysis (Chapter 1)	

2.3 PROJECT PURPOSE

2.3.1 Objectives of ENIDP

As stated in the project's ESMF (ERM 2007), the development objective of ENIDP is to increase Ethiopia's irrigated area through investments that are cost effective, environmentally and socially sound, and beneficial to the rural poor. In addition, the project aims to contribute to further strengthening of cooperation on the Nile between Egypt, Ethiopia and Sudan.

According to the Memorandum of Understanding (MoU) on project implementation (ENIDP-Amhara Region Project Coordination Office 2009) the development objective of the project is "to sustainably increase agricultural productivity in project areas", and the expected overall project result includes "increase in value added per worker" and "increase in value added per hectare".

According to the ESMF, the expected project results include (i) improved access to water on about 20,000 ha of land through investments in irrigation infrastructure, (ii) improved access to markets for inputs and produce through support to targeted supply chains, (iii) adequate management of irrigation through public-private partnerships, (iv) promotion of SME/SMIs and strengthening of the capacity of water users' associations, (v) satisfactory project management and use of resources in accordance with the project's objectives and procedures, and (vi) increased government support for agricultural intensification in irrigated areas through increased public expenditures.

In relation to irrigation development, it is expected that developing irrigation infrastructure will lay the infrastructural foundations for agricultural intensification, and directly benefit 20,000 households.

As stated in the MoU, "*the very significance of implementing this project is to transform rainfed subsistence agriculture into irrigated commercial agriculture*".

2.3.2 Objectives of MPIDP

The MPIDP Feasibility Study presents the objectives of the project as coinciding with those of the Water Resources Management Policy (1999) and Agricultural Development-Led Industrialisation (ADLI) policy (1995) with regard to the irrigation sub-sector, namely:

- Development of small, medium and large-scale irrigation for food security and food self-sufficiency at both the household and national levels as well as for producing agro-industrial raw materials and crops for export.
- Promotion of an efficient system of irrigation.

The MPIDP Feasibility Study does not include a project framework (logframe[27]) listing the project's objectives, outputs and impacts, performance indicators or means of verification, or assumptions.

2.3.3 Need for Project

The Feasibility Study's rationale for the project is that a transformation from subsistence, rain-fed traditional farming to an intensified, diversified and modernised agricultural system including irrigation is essential to improve the country's food security situation and create the conditions for sustainable development. This is in line with both ADLI and the GoE's Sustainable Development and Poverty Reduction Programme (SDPRP: GoE 2002).

According to the ToR for this ESIA, the selection of the irrigation schemes in the ENIDP is the result of a strategic analysis of potential irrigation developments in the Ethiopian Nile Basin completed for the MoWR in July 2006[28]. This analysis evaluated the relative attractiveness of nine potential schemes[29] based on technical, cost, environmental and social criteria. Based on this analysis, the then MoWR selected the schemes to be included for financing and/or study by ENIDP. The Megech pumped scheme (at Seraba, Guramba, Robit and Jarjer, a total of 24,179 ha) ranked first.

[27] Logframe: logical framework, a commonly used tool for conceptual analysis and for presenting a project's purpose, structure, activities, and management and monitoring methods at a glance, in the form of a table or set of tables.

[28] "Ethiopian Nile Irrigation and Drainage Project: Consultancy Service for Identification of Irrigation and Drainage Projects in the Nile Basin in Ethiopia". Tahal/MWH/Concert, July 2006.

[29] Megech pump, Megech gravity, Ribb, Upper Beles, Negeso (Didessa), Nekemte, Anger Dam, Dembi Gusu, Angereb (Tekeze Basin).

The Megech pumped project was first identified by USBR (1958-1964), then adjusted and reformulated by the Abbay River Basin Integrated Development Master Plan Project by BCEOM (1996-1999). It comprised four pumped irrigation projects, two on each side of the Megech River (Seraba and Guramba on the west, Robit and Jarjer on the east). Seraba and Robit would rely on pumping directly from Lake Tana; Guramba and Jarjer were to rely on further lifting of water from the Seraba and Robit main canals. Thus the Seraba and Guramba schemes would have to be developed first. In 2009 MoWR decided to develop the Guramba scheme using gravity irrigation from the new Megech Dam rather than pumping from Megech (Seraba).

2.3.4 Overview and Development Concept

The Seraba sub-scheme is one of three pumped irrigation projects together comprising the overall Megech pumped irrigation project, the others being Robit (6,532 ha) and Jarjer (10,020 ha) (Figure 1-2). Jarjer will rely on lifting water from the lower-elevation Robit scheme. Robit and Jarjer will be implemented later than Megech (Seraba), with alternate financing. In addition, MoWE is planning the construction of a dam on the Megech River which would irrigate an additional 7,300 ha by gravity, including the 6,640 ha Guramba area adjacent to the Megech (Seraba) scheme (the Megech Gravity I&D Scheme at Kola Diba, Jiwana, Guramba and Jarjer).

The project covers about 6,311 ha (the Project Command Area, PCA), with a net irrigable area of about 4,995 ha. Option III would see the development of some 4,040 ha for irrigation.

The development concept is for modern, large scale irrigation by smallholders, transforming the existing subsistence system to intensified commercial production: gravity irrigation will guarantee dry-season cropping, specifically of row crops, whilst flood protection will improve wet-season productivity. Land will be re-organised, WUAs will be created to manage the on-farm systems and recover O&M costs, the livestock system will be drastically modified by switching from extensive grazing to fodder-based production systems, and there will be a significant private sector involvement in service provision and system management.

Water for the scheme will be supplied by a pumping station on Lake Tana, near Gorgora, and a system of canals. The main canal will contour along the western and northern sides of the project. Secondary canals will lead water from the main canal into the command area, running downslope. From these, tertiary canals will run on the contours, serving standard size 2.0 ha or 4.0 ha irrigated plots by means of field ditches. Surplus irrigation water, and runoff from rainfall, will be removed by surface drains.

Irrigation will be by gravity, specifically furrow irrigation of row crops in the dry season.

Some 2,172[30] households will be involved in the scheme, as beneficiaries. Existing land holdings (an average of 1.07 ha in 3 to 6 plots) will be reorganised to standardise the irrigation layout, but maintaining plots in different locations. Farmers will be organised into compulsory Water Users' Associations (WUAs), which will collect fees.

The area available for grazing in the command area will be reduced, and more fodder grown on fields.

The scheme will be built by a contractor. Its off-farm components will be operated and maintained by a different private-sector entity contracted to MoWE for a period of 5 years. This organisation will also provide support to irrigation water users' associations (WUAs) and farmers and will be paid a fee for O&M and other services. The GoE will write off the capital investment, and will subsidise the O&M costs at a reducing rate in accordance with the farmers' increasing ability to pay. ANRS BoARD and private sector organisations will provide agricultural services and inputs as well as links to markets.

The main features of the project are summarised in Table 2-2.

[30] The exact number has been determined by the RAP study (SMEC 2010).

Table 2-2: Main Characteristics of Project

(Note: these data may be modified in the final design)

Item	Data
Command area	6,311 ha
Area to be irrigated	4,040 ha
Population	~ 11,179[31], household size ~ 5.5
Beneficiaries	~ 11,179 (~ 2,172 households)
Farm size (existing)	~ 1.07 ha, average 6 parcels, of which 0.61 ha (57%) cropped, 33% grazed, 10% other
Water demand per ha	7,600 m^3/yr (760 mm depth)
Total water demand	30-40 million m^3/yr
Pumping station	5 pump units rated at 350 kW, capacity 22,750 m^3/hr, head 17.5 m, operation 22 hrs/day, 120 m 1500 mm dia rising main to main canal; 300 m approach channel in lake
Main canal	20.7 km, capacity 6.0 m^3/s at headworks, width with banks ~ 30 m, unlined, 4 regulators with electrical gates
Structures on main canal	Stilling basin, measuring flume, 4 cross regulators, 5 aqueducts, 12 secondary canal head regulators, 10 drainage inverted siphons, 1 canal inverted siphons, 1 escape
Secondary canals	12 secondary, 12 sub-secondary, total 36.9 km secondary, 22.5 km sub-secondary, capacity 0.1 to 1.6 m^3/s, width with banks up to ~ 14 m, unlined; 152 turnouts and flumes, 40 drop structures, 20 drainage inverted siphons; plus 14 night storage reservoirs; operation of canals: 12 hrs/day
Tertiary canals	140, each with a command area of 10 - 40 ha, capacity up to 40 l/s (0.04 m^3/s), total length ~ 180 km
Drains	Main canal interceptor drain; 17 drainage crossings of main canal; 732 field drains, total length 266 km; 138 tertiary drains, total length 115.8 km; 6 primary drains, 12.44 km; 14 outfall drains (excavated along existing natural channels), 47.1 km; 132 outfall structures
Flood dykes	14 km (7 km of river)
Service & access roads	87 km
Bridges	3 road bridges on main canal, 41 road crossings on secondary canals
Land take for structures	309 ha
Associated services & infrastructure	Expanded government and private sector agricultural services
Construction period	24 - 36 months
Investment cost:	
Irrigation & conveyance infrastructure	ETB 118.4 million
Pumping station and gates	ETB 20.1 million
Drainage system and flood dykes	ETB 65.8 million
Other infrastructure	ETB 29.8 million

31 This number, 11,179, has been determined for the RAP and is less than half the PCA population estimated for the Feasibility Study (~24,000). This difference creates discrepancies in number of households as well as area per household.

Item	Data
On-farm infrastructure	ETB 47.4 million
Total	*ETB 282.21 million ~ USD 17.6 million ~ USD 4,400/ha*
EIRR	*18.4%*
Operating cost:	
O&M + energy charges	ETB 1,000/ha/yr
Affordability after full development	Unit on-farm water cost: ETB 0.46/m^3 Household cash availability after expenses: ETB 0.81/m^3

Sources: Tahal-CECE MPIDP Feasibility Study (Feb. 2010), draft RAP (SMEC Aug. 2010), MPIDP Detailed Design Report (July 2010)

2.4 Project Location

The MDIDP will develop some 4,000 ha of land on the north shore of Lake Tana, between the port of Gorgora and the Megech River (Figure 1-2, Figure 2-1 and Map 1, Annex 1). Water will be pumped from the lake near Gorgora, and then distributed by a primary canal running around the west and north sides of the low-lying command area in the Dembia Plain, some 8-15 km south of the Woreda headquarters town of Kola Diba, which is itself some 24 km south-west of Gonder.

Administratively, the MPIDP is situated in Dembia Woreda, North Gonder Zone, Amhara National Regional State (Figure 2-2). Affected Kebeles listed in the FS are Aberjeha Dhena, Achera Mariam, Arebia Kesugu, Chenker Cherkose, Debre Zuria, Guramba Bata, Jangua Mariam, and Seraba Dabelo. The PCA boundary also includes a small part of Meskele Kiristos Kebele (Map 1, Annex 1).

Figure 2-1: Proposed Megech Pump Project Command Area (Source: MPIDP FS)

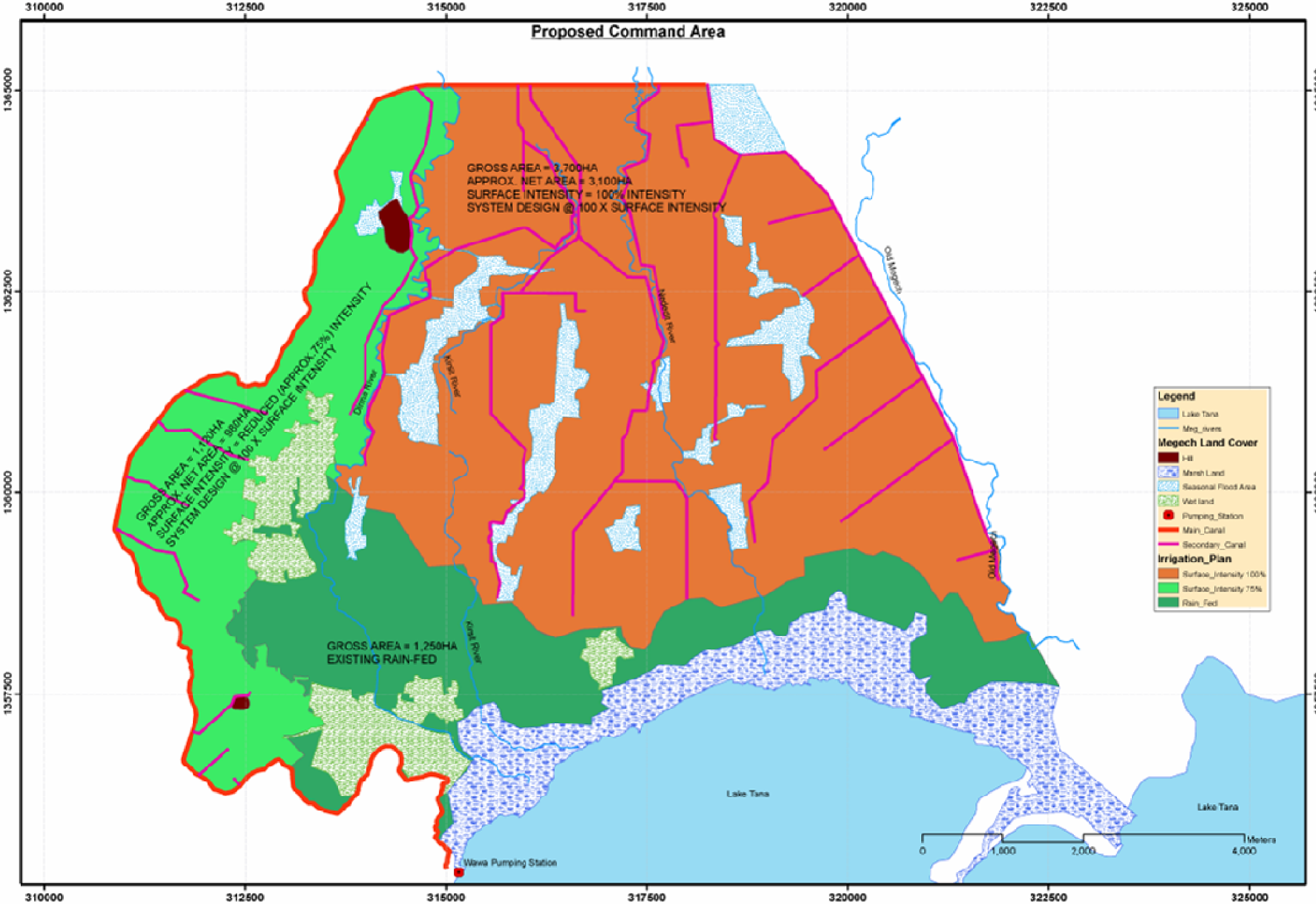
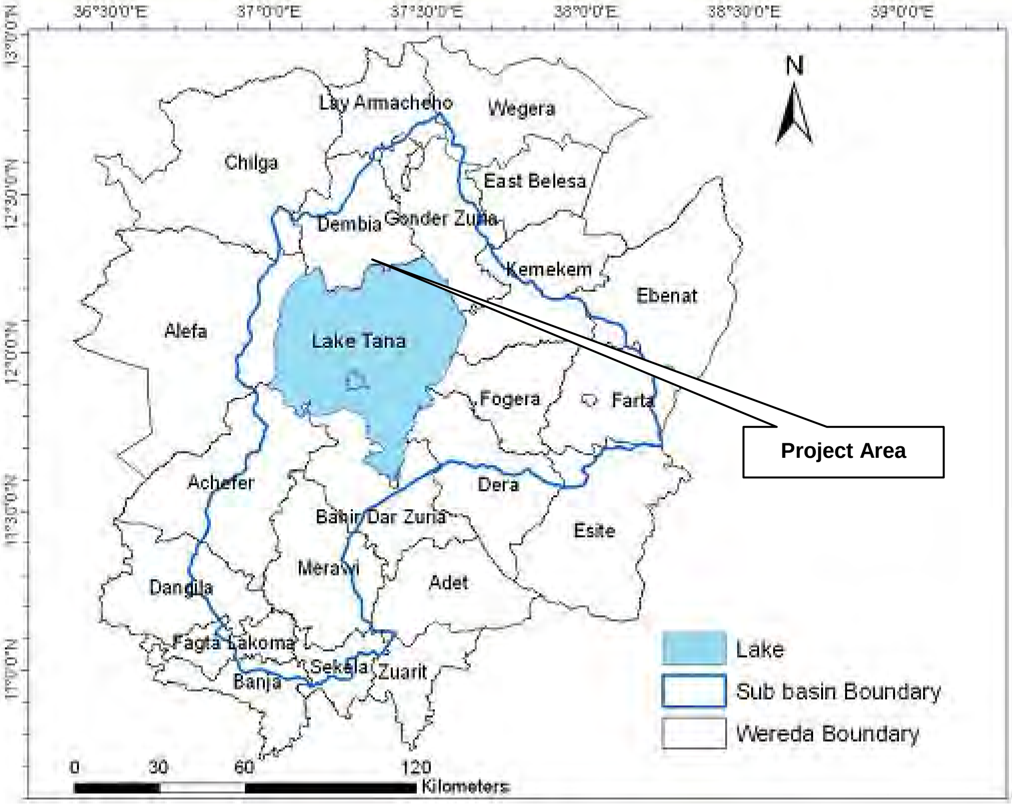


Figure 2-2: Amhara Region - Woredas



Source: Yilma & Awulachew (2009)

2.5 Project Design

2.5.1 Pumping Station and Administration Block

The pumping station will be located directly on the shore of the lake some 1.5 km north of the port of Gorgora (Photo 2-1, Figure 2-1). This site, a rocky headland, was chosen considering criteria including shortness of the approach channel, minimised disturbance to the existing shoreline, protection from the influence of the Dirma River, good foundation conditions (basalt), favourable topography in relation to the canal headworks, and a short rising main (pressurised pipe).

The 300 m approach channel in the lake is designed to operate at lake levels between 1784.00 m asl and 1788 m asl, and will have rockfill banks on both sides with access for maintenance vehicles.

The pumping station will be equipped with 5 vertical deep well turbine pumps, installed on a concrete platform above flood level and housed in a pump house. Each pump unit will be rated at 4,550 m^3/h against a head of 17.5 m, with rated power of 350 kW. Space will be provided for a future sixth pump. Electricity will be provided by EEPCo from the local grid (Gorgora) by a new 15 kV line to a new sub-station rated at 2,500 kVA. The station will have two 1,500 kVA transformers. Standby power will be provided by a diesel generating set rated at 2,000 kVA, with a 50 m^3 bulk fuel tank.

Photo 2-1: View south from Kurtiye Hill to pumping station site (middle distance) and Gorgora town

The pumping station will be provided with auxiliary features and equipment such as an overhead travelling crane (5 t), gantry crane (3 t), trashracks to prevent ingress of floating debris, steel stoplogs and sluicegates to isolate the wet well for maintenance, and instrumentation. Additional facilities will include storage, workshop, possibly staff accommodation, parking areas and security fencing around the compound.

From the pumping station, a single rising main (steel pipe, dia 1500 mm) 120 m long will carry deliver water to the headworks of the main canal. The maximum discharge at the headworks with all 5 pumps running would be 6.33 m^3/s.

An administration compound will be constructed on the access road to the pumping station and headworks.

2.5.2 Canals and Cross-Drainage

The main canal will be a contour canal 20.70 km long with an initial water surface elevation of 1,799.35 m asl and a final elevation (controlled by structures) of 1793.85 m asl (Map 2, Annex 1). The canal will be able to supply the whole PCA simultaneously during peak demand and therefore has a design discharge of 5.75 m^3/s at the headworks, falling to 5.00 m^3/s at Km 10.18 and 2.00 m^3/s at Km 18.57.

The first 5.28 km of the canal will pass through sloping, rocky terrain and will be concrete or clay lined to minimise seepage. The remaining 15.4 km will be in vertisols (black cotton soils) and will be unlined. The canal will have a trapezoidal cross-section with a bed width varying from 4.3 to 2.6 m and side slopes of 1:1.5 V:H. Water depths will vary from 1.55 m to 1.05 m at full supply, and the freeboard at these depths will vary from 1.23 m to 0.50 m.

The main canal will be provided with a service road on the command area side, and an interceptor drain of some 2 m^2 on the uphill side for the first 10 km. Thus the total width of construction for the first 10 km would be about 30 m, depending on side slope, and the remaining 10.7 km (without the interceptor drain) would be about 20 m.

The main canal will be provided with structures to control water levels and measure flow: flow will be measured by a concrete flume[32] at km 1.2. Four cross regulators with regulating gates will control water levels along the main canal, at km 5.28, 10.18, 14.43 and 18.57. The gates will be electrically operated with a manual over-ride. Power will be supplied by EEPCo (three phase 400/230V).

The main canal will have 15 cross-drainage structures:

- 5 aqueducts will carry the main canal across streams, some of which will have to be excavated to provide for safe passage of the 50-year flood. The aqueducts will be rectangular in reinforced concrete. The service road will cross the streams on fords or culverted crossings ("Irish bridges").
- 10 cross-drainage siphons will carry streams under the main canal. At these locations the canal and the streams are at almost the same level. The 50-year flood discharge of the streams varies from an estimated 1.23 m^3/s to 57.7 m^3/s. The siphons will consist of concrete pipes or reinforced concrete boxes, according to discharge.

32 Replogle flume.

- To cross the Dirma River, the main canal will be carried under the river channel in a rectangular reinforced concrete tube of around 2 x 2 m square and 155 m length. The design assumes that the Nededit River will be diverted into the old bed of the Megech River above the command area.

An escape structure will be provided at Km 17.15 near the Dirma River, for emergencies.

12 secondary and 12 sub-secondary canals will take off from the main canal and run down the prevailing slope towards the lake. These will be provided with constant head orifice headworks to control and measure the water supply from the main canal. This type of head regulator depends on a constant water level in the supply channel, and is relatively resistant to interference. The canals will have design discharges of between 0.065 m^3/s to 1.593 m^3/s and lengths of from 33 m to 7,846 m. They will be unlined. The total length of the secondary canals will be 60 km. Each canal will have a service road on the embankment on one side, either 3.0 or 4.0 m wide.

The secondary canals will be equipped with pre-cast concrete gated orifice turnouts for tertiary canals, masonry measuring flumes at each turnout, check drops every km (the natural slope is approximately 1 to 1.5 m/km; the canals are designed with a longitudinal profile of 0.22 to 0.40 m/km), and cross-drainage siphons (estimated 1 per 2 km; although the secondary canals run on very shallow ridgetops, there are some 25 locations where siphons will be required to prevent obstruction of natural drainage between depressions).

2.5.3 On-Farm Layout

Water from the secondary canals will be delivered to standard size irrigation plots by unlined tertiary canals, running on the contour, and field ditches (FD) perpendicular to the contour. The Field ditches will be designed and constructed by Water Users' Associations. Both the tertiary canals and the field ditches will have cross-gates to prevent downstream flow, as necessary.

The basic irrigation unit will be rectangular, 100 m x 200 m, and served by one field ditch. In some cases one ditch may be able to serve two plots. Each 2.0 ha plot will be divided into 8 sub-plots, probably farmed by different families.

The recommended irrigation method in the FS is furrow irrigation on the contour. Border irrigation (flooding of the entire field) is not recommended since it requires precise land levelling and creates a higher risk of waterlogging and salinisation. Water will be supplied to the 100 m long furrows from the field ditches by means of siphons (75 mm dia portable plastic pipe), gated outlets, or sub-field ditches. In general, the slope of the furrows will be 0.1 to 0.3%.

The FS proposes 267 furrows per basic irrigation unit, each 100 m long on the contour and 25-35 cm wide, served by furrows 40-50 cm wide. Land preparation, including precise levelling, will be carried out by beneficiaries.

2.5.4 Internal Drainage

The major sources of excess water in the PCA are (a) rainfall and (b) flooding from streams and rivers, exacerbated by (c) fluctuations in lake water levels. Drainage is required to (i) accelerate the removal of water during flood events, (ii) maintain groundwater levels sufficiently low so as to avoid waterlogging of plant roots and the risk of salinisation, and (iii) drain surplus irrigation water.

The PCA will be drained by a surface drainage system based on the main natural drainage channels, comprising:

- 732 field drains adjacent to each plot, total length of 266 km.
- 138 tertiary drains, total length 115.8 km.
- 6 primary drains, total length 12.4 km.
- 14 outfall drains, excavated along existing natural watercourses, outfalling to the Nededit, Dirma and Kirsit Rivers or directly to Lake Tana, total length 47.1 km.

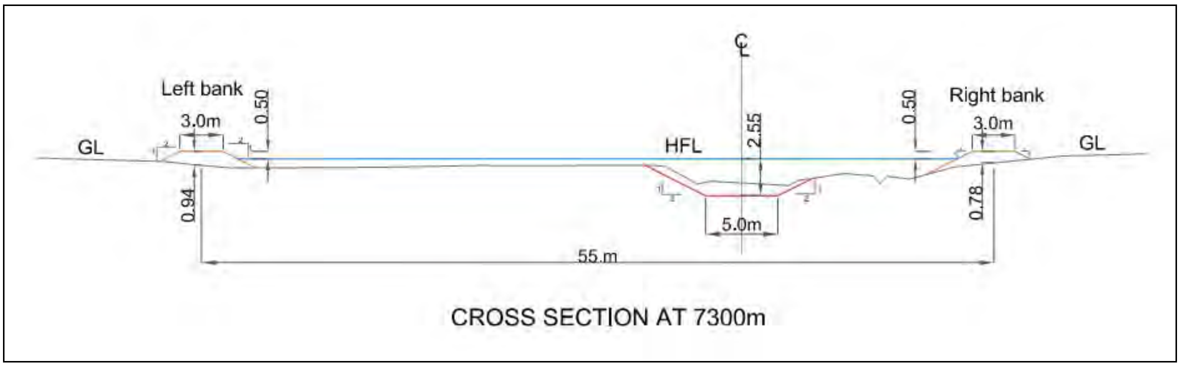
Field drain design is based on expected rainfall runoff, which at some 12.5 l/s per 2 ha plot is about three times the expected irrigation surplus runoff.

Note: the soils in the PCA are "black cotton soils" (vertisols), which are heavy clays with low hydraulic conductivity[33]. Water movement into these soils (infiltration), or sideways within them, is negligible except when the soils are very dry and have cracked, a characteristic of black cotton soils (Photo 4-3). Once wet, they swell and become, effectively, impermeable. Sub-surface drainage does not work in these soils.

2.5.5 Flood Protection

The PCA is drained by three main existing natural waterways, the Dirma, Nededit and Kirsit Rivers (catchment areas: 454 km^2, 62 km^2, and 13 km^2 respectively). The capacity of these channels is very small compared to their discharges, resulting in flooding over a large part of the PCA. Therefore (i) the Nededit will be diverted to the channel of the Old Megech River just above the PCA by the Megech Gravity I&D Project, (ii) the channels of the Kirsit and Dirma Rivers will be enlarged to provide for discharge of the 10-year floods; (ii) because it is not practical or economic to excavate the channels sufficiently for the 10-year flood, it is proposed that as well as some excavation the channel enlargements should include flood dykes along the banks of both the Dirma and Nededit Rivers. The dykes will be set back some 25 to 40 m from the existing river banks (~ 10 to 25 m from the banks of the future enlarged channels) (Figure 2-3). To avoid damage to the dykes during severe floods (>1 in 10 year return period) the dykes will be provided with spillways into the protected farmland.

Figure 2-3: Dirma River: Channelisation and Dyking Proposal - Typical Cross Section



Source: MPIDP FS Drawing C.3-8

2.5.6 Access: Roads and Bridges

It is proposed to construct some 87 km of unpaved roads, as follows (all figures approximate)[34]:

- Service road along main canal: 20.57 km.
- Service roads along secondary canals: 15.32 km.
- Combination road: 32 km.
- Access road: 5.5 km.
- Community link road: 13.81 km.

It is proposed that 3 road bridges should be constructed across the main canal, and 41 road bridges over the secondary canals (Figure 5-1). The service road along the main canal will cross the Dirma River by an "Irish crossing" (ventilated ford); the Nededit River will be diverted by the Megech Gravity I&D Project and therefore will not require a crossing.

It is expected that the community link roads will be built by the beneficiary communities.

2.5.7 Settlements

The canal and drain layout serves all cultivable land within the command area, irrespective of whether this lies within settlements or not. Within settlements the feasibility-level layout generally aligns canals and drains along existing plot boundaries, between houses. The FS does not provide details of how settlements will be reorganised to facilitate maximum irrigation development.

33 Hydraulic conductivity: measure of how fast water can move sideways through a soil.

34 Data from Annex C.5 of the Nov. 2009 MPIDP Draft Feasibility Study.

2.6 PROJECT OPERATION

2.6.1 Cropping Patterns

The project's water demand estimates and economic analysis are based on an assumed cropping pattern based on two crop combinations ("crop baskets") as shown in Table 2-3. In addition, some 2% of the arable land of the command area is judged to be suitable for tree and perennial crops such as banana, mango, avocado, guava, orange, and coffee.

The two baskets of field crops both allow double cropping (two crops per year), and in some cases a third crop of a quick-maturing vegetable such as peas or beans.

Table 2-3: Proposed Crop Baskets for the MPIDP

	Crop	Basket 1 (% of area)	Basket 2 (% of area)
Wet season crops (rainfed)	Rice	50	50
	Teff	25	25
	Niger seed	15	15
	Finger millet	10	10
Dry season crops (irrigated)	Vegetables/spices	25	20
	Cereals	25	20
	Oil crops	25	20
	Pulses	25	20
	Industrial crops	0	20

Source: Feasibility Study Table C.1-3

2.6.2 Operation during Peak Demand

Peak water demand for the proposed crops will occur in February. During this period the irrigation interval will be 8 days, to avoid repeated demands for work on Sundays on the same tertiary canals.

Under this system water will be supplied to farmers' plots every 8 days. The recommended method of operation is that the tertiary canals are maintained at full supply level, but only 1 in every 8 field ditches is operated on any one day. Therefore each tertiary canal only needs to supply 1 in 8 plots on any one day. At peak demand, the secondary canals will provide 140 m^3/hr to the tertiary canals, which will provide 129 m^3/hr to one field ditch for one day of 12 hours of operation (06:00 to 18:00). The flow in the field ditch, 119 m^3/hr, will be diverted to a group of 66 to 67 furrows for approximately 3 hours, and then to the remaining groups of furrows in the plot, in succession. (The reduced flows along the system of canals and ditches reflect losses due to seepage, evapotranspiration[35], etc.).

The FS describes several methods for irrigation scheduling at field level (determination of the best timing and volume of water required for the specific crop being grown) based on water balance methods or soil moisture measurements, but does not provide details of the organisation which will undertake this during project operation.

2.6.3 Operation during Reduced Demand

Reduced irrigation demand will be experienced from October to June, except February. At this time the irrigation interval will remain 8 days, but water will be applied to each plot for less time. July, August and September are peak rainy season months, and no irrigation demand is forecast for this period. However, canals will be kept filled in order to prevent soil cracking and seepage losses.

35 Evapotranspiration (ET): water uptake by plants and its subsequent evaporation from the leaves.

2.7 Associated Features, Facilities and Services

2.7.1 Livestock

With respect to livestock feed, the FS recommends that some 8% of the irrigated area should be dedicated to rainfed grazing, and that 5% of the 4,000 ha to be irrigated should be allocated for fodder crops. These would be grasses such as Elephant grass, Guinea grass, Setaria, Rhodes grass, and Phalaris, with some persistent legumes such as Greenleaf Desmodium.

In addition, the FS recommends (i) the planting of leguminous trees and shrubs in hedges around homesteads (Sesbania, Leucaena, Tree Lucerne, Pigeon Pea), (ii) undersowing forage legumes into sorghum and maize, (iii) using anti-erosion contour strips for forage production, (iv) establishment of mixed pasture based on Rhodes grass and conserving this as hay or silage, (v) growing annual and short-term perennial forage for cut-and-carry systems, (vi) over-sowing grazing land with robust (grazing-tolerant) legumes, and (vii) improving crop residues as a source of feed through better handling, storage and treatment to increase palatability and digestibility.

With respect to livestock improvement, the FS proposes (i) breed improvement by artificial insemination, (ii) cattle and small-ruminant fattening, including use of the indigenous dual-purpose Fogera cattle for this purpose, (iii) improvement of poultry breeds, (iv) promoting beekeeping and increasing hive yields by better training, technologies and equipment, and (v) improving veterinary services.

The FS does not provide any details of the organisation which would promote and deliver these livestock-related programmes and services.

2.7.2 Extension Services

The FS emphasises the importance of technical support to the success of the scheme:

> *"Promoting irrigation without building up the professional leadership to support growers in their more complex day to day decision-making is not possible".*

The FS then provides details of the type of services required and methods recommended, including a technical database, extension agronomists, participatory decision-making by producers, field trials and demonstration plots, extension and adoption of technologies by producers, written guidelines for commodity production, systematic crop protection and the use of pesticides, formulation of IPM principles, crop protection extension specialists, Quality Management techniques, inspections and training by field agents of processing and marketing bodies, use of mass media, advisors recruited from recent university graduates, experienced field technicians, overseas training of extension advisors and researchers, in-service training to build up team field expertise, crop-soil-water laboratories, weather stations, use of monitoring and evaluation as a dynamic management tool, involvement of subject matter specialists, technical advisors and leading growers in M&E, site-specific research especially of the irrigation and fertiliser requirements of the major crops in the area, training of trainers, etc. The FS does not provide any details of the organisation which might supply these specialists and services, or how they will be funded.

Support for extension services is provided under Component 2 of ENIDP, Agricultural and Market Development (US$17.0 million total, including IDA funding of US$13.5 million, Borrower financing of US$0.6 million and a Beneficiaries' contribution of US$2.9 million)[36]. This component will provide resources to support the delivery of advisory services, adaptive research and development, the strengthening of research-extension-farmer linkages, the improvement of market linkages, and increased pluralism in market delivery. Activities under this component are being implemented by the ANRS BoARD, and include a market assessment study (Langmead *et al.* 2007), development of action plans for commercial production of oilseeds and pulses (NIRAS 2009), and a series of small-scale research activities under the leadership of ARARI (see list at Annex 4.3).

Component 3 of ENIDP, Irrigation Management, will develop and strengthen water user associations and promote public-private partnerships in irrigation infrastructure management.

[36] World Bank: Project Appraisal Document, 2007.

2.7.3 Credit

The FS states that credit is a prerequisite for successful implementation of the project. It suggests that credit would be provided to farmers either via growers cooperatives, or by cooperative agro-industries, and that government intervention could be in the form of safety nets, reduced interest rates, or crop insurance.

2.7.4 Inputs

The FS states that technical service centres - for the supply of tools, packaging, mechanical services etc. - will be established "near villages such as Kola Diba and at the relevant Kebele level, and for certain services at urban centres such as Gonder". Costs would be recovered on a fee basis. No implementation details are provided.

According to the FS, at present about 90% of the seeds used in the PCA are local seeds stored by farmers from the previous year's harvest. No seed-dressing is undertaken, leaving seeds vulnerable to soil pests and seed-borne diseases. Some planting materials are often difficult to find (e.g. sweet potato, potato, garlic and good quality tomato seeds). The FS proposes that service centres and agricultural input outlets should carry quality planting material sourced from both the Ethiopian Seed Enterprise (ESE) and from overseas.

At present farmers obtain fertiliser (DAP, urea) from the Woreda Agriculture and Rural Development Office through farmers' service cooperatives. This system is affected by constraints such as high prices, limited access, delays in delivery and lack of flexibility. The Study proposes that fertilisers are made available to growers at fair prices "at service and supply centres to be established in the region" by grower organisations, government or the private sector.

2.7.5 Mechanisation

The FS proposes that, initially, hand-operated two-wheel mechanised cultivation tools be introduced to enable the creation and maintenance of uniform furrows and flat seed-beds and to incorporate fertiliser into the soil. Tractors would be introduced later.

2.7.6 Crop Storage, Processing and Marketing

The FS does not provide details of the crop storage, processing or marketing systems necessary for scheme operation. As noted, the development of links to markets is the subject of ENIDP Component 2.

2.7.7 Electricity and Other Infrastructure Development

The FS does not provide information on the provision of electricity to the PCA except to the pumping station, which will be done by the Ethiopian Electric Power Corporation (EEPCo), or on the provision of any other infrastructure development apart from the roads, bridges and flood dykes described above.

2.7.8 Social Development

The FS does not provide information on social development objectives or initiatives such as improvements in literacy, micro-credit, health, domestic water supplies or sanitation.

2.8 MANAGEMENT PROPOSALS

2.8.1 Roles of Major Players

The arrangements for project implementation are understood to be as follows:

Land acquisition and redistribution

- Land acquisition and redistribution will be carried out by Dembia Woreda Administration, specifically the Woreda-level Environmental Protection, Land Administration and Use Office, and within this the department of Rural Land Administration. The land consolidation process will be supported by the Private Sector Participation (PSP) contractor under its Management Services Contract (MSC) with MoWE.

Construction

- Construction will be carried out by a private sector contractor commissioned through a standard international tendering procedure in compliance with World Bank procurement rules.
- Construction supervision will be carried out by a separate internationally-selected contractor (the PSP contractor), on behalf of MoWE.

Operation

- The PSP contractor will also (i) operate and maintain the off-farm components of the system for a set period (5-6 years), (ii) provide "customer services", specifically the collection of water-user fees from WUAs on behalf of GoE, (iii) provide advice to WUAs and farmers, and (iv) undertake various aspects of monitoring, during (a) the transition period of land reallocation and construction, and (b) normal operation and maintenance.

The operation and maintenance contractor may be encouraged to provide services such as extension, inputs, and marketing by incentives including a matching grant mechanism (source of funds: the IDA) and the potential for profiting from added value.

GoE will:

- Own the scheme (the infrastructure).
- Pay the costs of construction.
- Pay the operator an operator's tariff to cover the full costs of O&M of the scheme.
- With the regional government, arrange for programmes of agricultural extension, other agricultural services and links to market.

Farmers will:

- Organise into WUAs to operate and maintain their on-farm systems.
- Provide a "beneficiary contribution" in kind, by constructing their own field channels (field canals and field drains), by levelling their land to permit furrow irrigation, and by constructing community roads.
- Pay a user fee for water which will gradually increase until it covers the full costs of off-farm O&M.

2.8.2 Project Implementation

The roles and responsibilities of different organisations for implementation of ENIDP (which covers a number of irrigation and drainage projects around Lake Tana) are set out in the *Memorandum of Understanding among Implementing Agencies on the Project Management and Implementation Modality* (ENIDP-Amhara Region Project Coordination Office 2009). According to the MoU:

- The MoWE, specifically a Project Coordination Office (PCO) headed by a National Project Coordinator (NPCO), is responsible for overall coordination of the project. The NPCO is guided by a National Project Steering Committee (NPSC) chaired by the State Minister of MoWE.
- At regional level, the Office of the Regional President appoints a Regional Project Coordinator (RPC) to head a Regional Project Coordination Office (RPCO) housed in the Bureau of Finance and Economic Development (BoFED) in Bahir Dar. The RPC coordinates project activities among participating agencies in the region, in particular BoWRD, BoARD, ARARI, BoEPLAU and CPA, and also liaises with participating Woredas and Kebeles. The RPC will be guided by a Regional Project Steering Committee (RPSC) chaired by the Regional President and comprising representatives from relevant departments and also WUAs, local universities, NGOs and the private sector, as appropriate. In addition to project oversight and guidance, the RPSC has a monitoring and evaluation role.

- At zonal level, the zonal administrator for North Gonder Zone is responsible for overseeing implementation of ENIDP in general and woreda project activities in particular.
- At woreda level, the Dembia Woreda Office Administrator is responsible for coordinating and directing the project, and for chairing a Woreda Project Implementation Team (WPIT) comprising heads of relevant departments (Agriculture and Rural Development, Water Resources, Environmental Protection, etc.). The head of the Office of Agriculture and Rural Development serves as the secretariat for the WPIT.

  Amongst other duties, the WPIT is responsible for (i) capacity building for farmers in irrigated agriculture, (ii) capacity building for applied research and extension services, (iii) assisting communities in selecting and contracting local service providers, (iv) assisting communities to establish WUAs, and (v) the introduction of three grants: (a) Farmers Advisory Service Fund (FASF); (b) Advisory Service Development Fund (ASDF); and (c) Fund for Farmer-Research Extension Groups (FREG).

2.8.3 Off-farm Operation and Maintenance

As noted above, off-farm O&M will be carried out by a private sector contractor. After the contract period of 8 years, the contract will be re-negotiated or re-tendered to transfer additional risk (and associated opportunity) to the private sector.

2.8.4 On-farm Operation and Maintenance

Operation and maintenance of tertiary canals and drains and associated structures will be by WUAs established as legal entities under the new WUA legislation (in preparation).

- The tertiary canals and drains and all structures (gates, pipe outlets, regulators) will require annual maintenance by the concerned WUA.
- Field ditches and field drains will require maintenance by the 8 users of each basic irrigation unit - weed removal and maintenance of slopes and profile.
- Furrows will require continuous maintenance by the individual sub-plot users.

2.9 PROJECT CONSTRUCTION

The FS and Detailed Design Report do not provide details of the construction process. The following description is based on discussions with key informants and the Consultant's experience.

The project has been packaged as a single contract for International Competitive Bidding (ICB) in line with the Bank's rules for procurement. The client (Owner) will be the MoWE. Construction supervision will be provided by an independent consulting firm on behalf of the Owner.

The FS assumes a 24 month construction period. The ToR for the management services contract (MSC), which includes construction supervision, provides for a phased, 36 month construction period.

Land for construction camps will be provided by the Woreda. The locations of the camps have not been determined yet. One will be close to or at the pumping station. Others will be required elsewhere near or in the PCA.

Land for construction of the permanent works (pumping station, canals, drains, access and service roads) will be provided by the Woreda following completion of the necessary compensation and resettlement actions in accordance with the project's Resettlement Action Plan (RAP)[37].

The labour force will be several hundred, comprising the supervision consultant's skilled staff, the contractor's skilled staff, semi-skilled staff including technicians, equipment operators and drivers, unskilled labourers, and site security personnel.

Construction materials will be sourced as follows:

- Aggregates (sand and gravel) and rock: from local borrow pits, from the Megech and other rivers (subject to further testing), and from sites near Gonder.
- Fill: from surplus excavation and from borrow pits.
- Cement, steel (re-bar), fuel, other miscellaneous supplies: from the local (Ethiopian) market.
- Electrical and other specialised equipment, including the pumps and transformers: imported.

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[37] In preparation by SMEC for the MoWR, in line with the Resettlement Policy Framework for ENIDP (ERM 2007). A draft became available in August 2010.

As noted, the beneficiaries are expected to contribute to the project by designing and constructing field ditches and drains, levelling their re-allocated and consolidated plots, and building community link roads.

2.10 PROJECT TIMING AND PHASING

The project is intended for fast-track implementation. Loan financing for the project (see next Section) is understood to have an 8-year implementation period. GoE will provide top-up funding.

The economic analysis in the FS assumes a theoretical schedule for project implementation and yield improvement: a 5-year Stage 1, including 2 years for construction, a 4-year transition period, and full production from Year 10.

Tendering will be carried out during 2011. Award of contracts will be dependent on approval of project financing. This in turn will be dependent on approval by MoWE and the Bank of the project's design, economics, RAP and environmental and social sustainability. Implementation of the project on the ground will depend on compliance with milestones in the project's RAP and any loan conditionality linked to measures in the Environmental and Social Management Plan (ESMP).

The earliest that construction could commence on a large scale would be the 2011-2012 dry season. Construction would then be complete by the end of 2013 at the earliest.

The ToR for the MSC described a phased construction and implementation process: irrigation would commence on the west side of the Dirma River in Project Year 3 (980 ha) before rolling out to the east (3,060 ha) in subsequent years. An initial 70% uptake is assumed, giving the actual irrigated areas by year shown in Table 2-4.

Table 2-4: Irrigated Area by Project Year (ha)

Irrigated area	1	2	3	4	5	6	7	8
Phase 1			686	735	833	931	980	980
Phase 2				2,142	2,295	2,601	2,907	3,060
Total	-	-	686	2,877	3,128	3,532	3,887	4,040

Source: ToR for Management Services Contract

2.11 PROJECT FINANCING

The project will be financed through a Specific Investment Loan (SIL) from the International Development Association (IDA), an arm of the World Bank. The loan will have an 8-year implementation period, and will include construction of the Ribb I&D Project.

3. Policy, Legal and Administrative Framework

3.1 Introduction

This chapter outlines the policy, legal and administrative framework governing environmental issues in Ethiopia, highlights other relevant policies, laws and institutions, and reviews applicable international policies and legislation including that of the project's international sponsor, the World Bank.

Note: the gaps and challenges faced by Ethiopia's EIA system as a whole have been reviewed recently in Mellesse Damtie & Mesfin Bayou (2008).

3.2 National Environmental Policy, Laws and Institutions

3.2.1 Institutional Framework

As stated in the MPIDP FS (Tahal-CECE 2010), in 1995, the EPA was created by means of the Environmental Protection Authority Establishment Proclamation (Proclamation No. 9/1995). At the same time, an Environmental Protection Council (EPC) was established, with representatives from most of the federal ministries to supervise the EPA's activities. The Director-General of the EPA was to serve as the Secretary to the Council and the EPA took on the duties previously assigned to the Ministry of Natural Resources Development and Environmental Protection (MoNREP). The mandate and duties of the EPA were subsequently clarified in the Establishment of Environmental Protection Organs Proclamation (Proclamation No. 295/2002).

The EPA is an independent authority, acting outside the main ministerial structures and reporting directly to the prime minister. The federal EPA is the key national level environmental agency, with a mandate to address environmental issues. The environmental legislation gives the EPA powers to fulfil its role, support all federal agencies in establishing environmental units, and develop skills in strategic environmental analysis of policies and public instruments. The EPA is involved in the development of environmental policy and legislation, setting environmental quality standards for air, water and soils, monitoring pollution, establishing EIA procedures and an environmental information system, and undertaking capacity development in relevant agencies to ensure the integration of environmental management in policy development and decision making.

The federal EPA is responsible for:

- Establishment of a system for environmental assessment of public and private sector projects, as well as social and economic development policies, strategies, laws, and programs of federal level functions.
- Review, decision-making and follow-up implementation of environmental impact study reports for projects, as well as social and economic development programs or plans where they are subject to federal licensing, execution or supervision; also proposed activities subject to execution by a federal agency, likely to entail inter- or trans-regional and international impacts.
- Notification of its decision to the concerned licensing agency at or before the time specified in the appropriate law or directives.
- Auditing and regulation of implementation of the conditions attached to the decision.
- Provision of advice and technical support to the regional environmental agencies, sectoral institutions and proponents.
- Making its decisions and the EIA report available to the public.
- Resolution of complaints and grievances in good faith and at the appropriate time.
- Development of incentives or disincentive structures required for compliance with regional environmental agency requirements.

3.2.2 Environmental Policy and Strategies

3.2.2.1 National and Regional Conservation Strategies

As stated in the MPIDP FS, the major environmental and natural resources management issues facing Ethiopia are well documented in the Conservation Strategy of Ethiopia (FDRE, 1997). The CSE sets out detailed strategies and action plans as well as the institutional arrangements required for the implementation of sectoral as well as cross-sectoral interventions for the management of Ethiopia's natural, man-made and cultural resources. The CSE provides a strategic framework detailing principles, guidelines and strategies for the effective management of the environment. The most important areas that are considered in the document include the following:

- Improvement of soils, crop and animal husbandry for sustainable agricultural production.
- Management of forest and woodland resources.
- Development of water resources for irrigation, hydroelectricity and water supply.
- Rangeland management and pastoral development.
- Promotion of individual participation in sustainable development of natural, artificial and cultural resources, and environmental protection.
- Land resource use policy and strategies; physical land use planning.
- Integration of social, cultural and gender issues in sustainable resources and environmental management.
- Development of environmental education, public awareness and human resources.

Implementation of the CSE required the formulation of region-specific conservation strategies in line with federal environmental policy, which was approved in 1997. Consequently, the ANRS government established a Regional Conservation Strategy Steering Committee to facilitate formulation of the regional conservation strategy (RCS). Accordingly, the Steering Committee organized a technical team by pooling experts from relevant sectors within the region, and the Amhara National Regional State Conservation Strategy document was prepared in July 1999. The work is presented in three volumes, namely: Resource Base; Policy Issues, Including Institutional Framework; and Action Plan and Investment Programs.

3.2.2.2 Environmental [Protection] Policy of Ethiopia

As stated in the MPIDP FS, in 1997 the government adopted the Environmental Protection Policy of Ethiopia, which is based primarily on the conservation strategy of the country. The policy consists mainly of guiding principles and various sectoral and cross-sectoral policies for sustainable environmental management.

The principal features of the Environmental Protection Policy of Ethiopia are:

- Provides for protection of human and natural environments.
- Provides for an early consideration of environmental impacts in projects and program design.
- Recognizes public consultation.
- Includes mitigation plans and contingency plans.
- Provides for auditing and monitoring.
- Establishes legally binding requirements.
- Institutionalizes policy implementation.

3.2.3 Environmental Laws

3.2.3.1 Constitution of the Federal Democratic Republic of Ethiopia (1995)

As stated in the MPIDP FS, the Constitution is the supreme law of the country, whose provisions all other policies, regulations and institutional frameworks must comply with. The Constitution of the FDRE (Proclamation No. 1/1995 as amended) is the foundation for human rights, and natural resources and environmental management. The Constitution states that:

- Government and all Ethiopian citizens shall have the duty to protect the country's environment and natural resources.
- Design and implementation of programs and projects of development shall not damage or destroy the environment.

- The People have the right to full consultation and expression of views in the planning and implementation of environment policies and projects that affect them directly.

The concepts of sustainable development and environmental rights are enshrined in the Constitution of the FDRE. Article 44 of the revised Constitution of the FDRE states that all persons who have been displaced or whose livelihood has been adversely affected because of state programs have the right to commensurate monetary or alternative means of compensation, including relocation with adequate state assistance. However, the compensation does not take into account the value of land.

3.2.3.2 Establishment of Environmental Protection Organs (Proclamation No. 295/2002)

As stated in the MPIDP FS, this law clarifies the institutional mandate and responsibilities of the EPA and aims to integrate environmental considerations into the policies and decision-making of sectoral agencies through such means as the establishment of environmental units in these agencies at the federal level and the creation of independent environmental agencies at the regional level.

This law also re-established the Environmental Council, a cross-sectoral co-coordinating body that advises the federal EPA and supervises its activities. The mandate of the Council includes: (i) reviewing environmental polices, strategies and laws proposed by the EPA and issuing recommendations to government; (ii) providing appropriate advice on the implementation of the Environmental Protection Policy of Ethiopia; and (iii) reviewing and approving directives, guidelines, and environmental standards prepared by the EPA.

Importantly, the proclamation also requires all 'competent agencies' (such as the MoWE) to establish or designate a sectoral environmental unit responsible for coordination and follow up to ensure that activities are in line with the proclamation and with other environmental protection requirements.

3.2.3.3 Environmental Impact Assessment (Proclamation No. 299/2002)

As stated in the MPIDP FS, this Proclamation (No. 299/2002) aims primarily at making the EIA mandatory for categories of projects specified under a directive issued by the EPA. The law specifies the projects and activities that will require an environmental impact assessment (EIA). The proponent of the project must prepare the EIA following the format specified in the legislation. The EPA will then review the EIA and either approve the project (with or without conditions) or reject it. Under this legislation, the EPA has to prepare procedures, regulations, environmental guidelines and standards for the EIA. Environmental guidelines are among the tools for facilitating the consideration of environmental issues and principles of sustainable development and their inclusion in development proposals. The Proclamation requires, among other things:

- Specified categories of projects to be subjected to an EIA and receive an authorization from the EPA or the relevant regional environmental agency prior to commencing implementation of the project.
- Licensing agencies to ensure that the requisite authorization has been duly received prior to issuing an investment permit, a trade or operating license or a work permit to a business organization.
- The EPA or the relevant regional environmental agencies may issue an exemption from carrying out an EIA in projects with an insignificant environmental impact.
- A licensing agency may suspend or cancel a licence that has already been issued where the EPA or the relevant regional environmental agency suspends or cancels environmental authorization.

Procedures that need to be followed in the process of conducting an environmental impact assessment are described in the Proclamation. Thus a project developer is expected to act as follows:

- Undertake a timely environmental impact assessment, identifying the likely adverse impacts, incorporating the means of their prevention, and submitting the environmental impact study report accompanied by the necessary documents to the EPA or the relevant regional environmental agency.
- Ensure that an environmental impact assessment is conducted and an environmental impact study report is prepared by an expert who meets the requirements set forth by the directive issued by the EPA.
- Submit an environmental impact study report to the EPA or the relevant regional environmental agency for review.

3.2.3.4 Environmental Pollution Control (Proclamation No. 300/2002)

As stated in the MPIDP FS, Proclamation No. 300/2002 on Environmental Pollution Control primarily aims to ensure the right of citizens to a healthy environment and to impose obligations to protect the environment of the country. The law addresses the management of hazardous waste; establishment of environmental quality standards for air, water and soil; and monitoring of pollution. The problem of improper handling of hazardous substances related to activities such as pest management and industrial development are becoming a serious environmental concern. In this connection the Proclamation provides a basis from which the relevant environmental standards applicable to Ethiopia can be developed, while sanctioning violation of these standards as criminally punishable offences.

In order to ensure implementation of environmental standards and related requirements, inspectors belonging to the EPA or the relevant regional environmental agency are empowered by the Proclamation to enter, without prior notice or court order, any land or premises at any time, at their discretion. Such wide powers derive from Ethiopia's serious concern and commitment to protecting the environment from pollution.

3.2.4 Regional Environmental Protection Framework

As stated in the MPIDP FS, the Environmental Protection Organs Establishment Proclamation (Proclamation No. 295/2002) provides for the establishment of regional environmental protection organs. Based on this proclamation, ANRS established the Environmental Protection and Land Use Authority (EPLAUA: now renamed the Bureau of Environmental Protection, Land Administration and Use (BoEPLAU)) with a view to ensuring conservation of the natural resources in the region. BoEPLAU's responsibilities include:

- Adoption and interpretation of federal level EIA policies and systems or requirements in line with their respective local realities.
- Establishment of a system for EIA of public and private projects, as well as social and economic development policies, strategies, laws and programs of regional level functions.
- Notification to the federal EPA about malpractices affecting environmental sustainability and cooperation with the federal EPA in investigation of complaints.
- Administration, oversight, and major decision-making regarding assessment of the possible regional impact of projects in the process of licensing and execution.

Regarding projects and activities under the jurisdiction of the federal EPA, the equivalent regional environment offices are required to verify or confirm that:

- Biophysical and socio-economic baseline conditions are adequately and truly described.
- Major issues are well defined during scoping and explicitly indicated in the Terms of Reference (ToR).
- Interested and affected parties or their representatives are provided with all means and facilities (e.g. notices, assembly halls, reasonable time, understandable language), enabling them to adequately air their views and concerns.
- Interested and affected parties have agreed to and are satisfied with the terms of compensation and the appropriateness of the Environmental Management Plan (EMP).
- Environmental monitoring activities are undertaken within an appropriate time with the involvement of interested and affected parties, and regular reporting is made in good faith and time to all concerned.
- The proponent/consultant meets the local and regional legal and policy requirements and obtains the necessary permits.
- Envisaged benefits to the communities and regions are tangible.
- The monitoring plan is logical and allows the participation of relevant bodies in the region.
- The strategy for impact communication and reporting is understandable and appropriate for regional level stakeholders.
- The minutes of the consultation process reflect a true and unbiased account of the opinions and interests of the interested and affected persons at the local level.

BoEPLAU insists on the preparation of an EIA in the case of major projects. It goes further by requiring EIAs for those projects that have already started operating without an EIA having been conducted, e.g. an integrated agro-processing industry near Lake Tana, which is required to prepare an EIA document following the advice of the regional environmental agency. The region adopts and uses national proclamations on EIA and pollution control. Guidelines, standards and regulations are required to assist in the implementation of these important proclamations.

BoEPLAU conducts periodic environmental monitoring of development projects; however, due to financial and material limitations, monitoring activities are confined mostly to the Bahir Dar and surrounding area. Monitoring is conducted twice a week in and around Bahir Dar, whereas in more remote parts of the region monitoring is performed annually due to vehicle problems. The monitoring team is multidisciplinary in makeup, including professionals such as chemical and industrial engineers, socio-economic experts, environmentalists, livestock and feed experts, civil construction engineers, soil and water conservation specialists, architects, and crop production experts. Of the total professionals, nine are recognized as environmental inspectors.

According to BoEPLAU, the major pollution sources in Lake Tana are drainage from Bahir Dar town, various solid and liquid wastes from facilities around the lake (hospital, jail, hotels, garages), and drainage from agricultural fields containing fertilizers and pesticides. Felege Hiwet Hospital has constructed a treatment plant to prevent contamination of Lake Tana with pollutants from the hospital.

3.2.5 Environmental Permitting Procedures

In Ethiopia, it is normal practice for major projects promoted by the Ministry of Water and Energy and other ministries to be regulated by the federal Environmental Protection Authority (EPA) in consultation with the concerned regional regulator (in this case the ANRS BoEPLAU). Under some circumstances these powers may be delegated to line ministries, such as MoWE.

Definitions of parties in the environmental permitting process in Ethiopia are given in Table 3-1. A flowchart of the process is given in Figure 3-1.

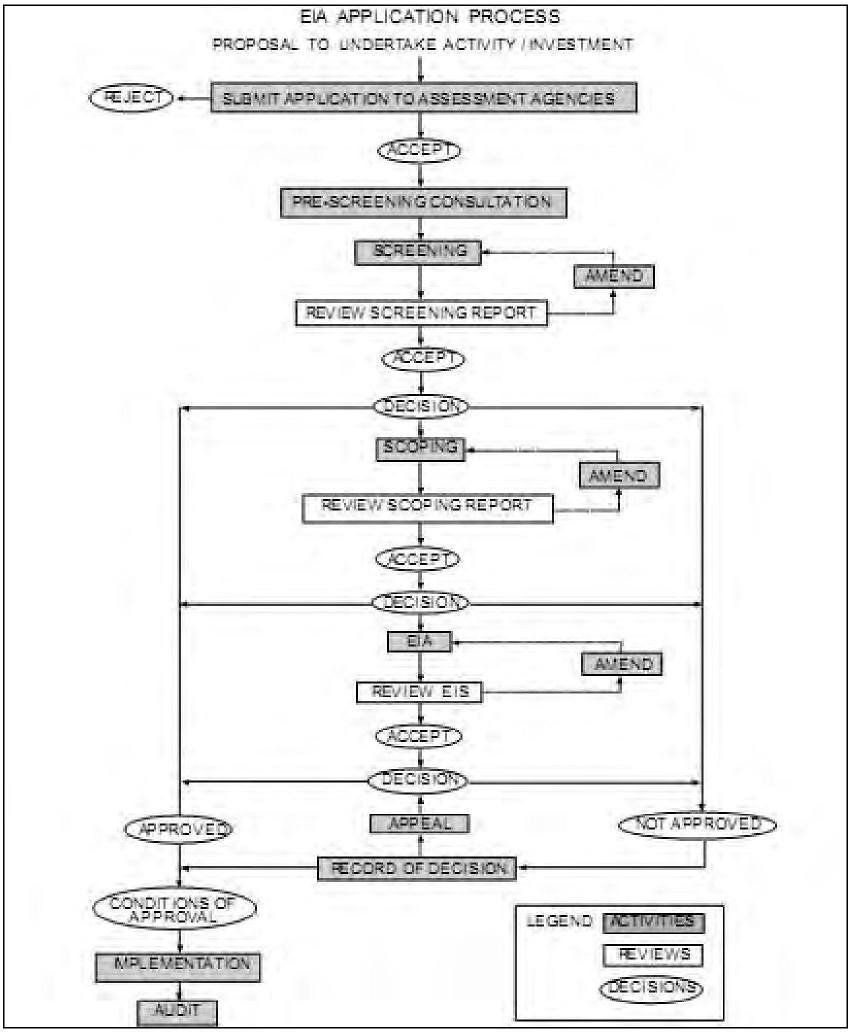
As a surface water fed irrigation project covering more than 100 ha and a project in an environmentally sensitive area, the MPIDP is a Schedule 1 project according to the EIA Guideline Document (EPA 2000) and therefore may require full EIA.

Table 3-1: Definitions of Parties in Environmental Permitting Process

Entity	Definition
Proponent	Any person that initiates a project, policy or programme, if in the public sector an organ of government, if in the private sector an investor. *In this case, the MoWE.*
Environmental Agency	Either the EPA or the Regional Environmental Body mandated by the Proclamation for the Establishment of Environmental Protection Organs (Proc. No. 295/2002) and Environmental Impact Assessment Proclamation (Proc. No. 299/2002) and other relevant laws to oversee and facilitate the implementation or administration of EA.
Licensing Agency	Any organ of government empowered by law to issue an investment permit, trade or operating license or work permit or register business organisation as a case may be.
Consulting Firm	An institution that can command the required qualified professional working group that has demonstrated the ability to undertake the EA, and meets the requirements specified under the relevant law. Appointed to work on behalf of a proponent. *In this case, BRLi in association with MCE.*
Interest and Affected Parties	Individuals or groups concerned with or affected by the proposed activity or its consequences. These may include local communities, the work force, customers and consumers, environmental interested groups and the general public.

Source: EIA Procedural Guideline Series 1, EPA, Nov. 2003

Figure 3-1: Flowchart for EIA and Environmental Permitting Process



Source: ESMF (ERM 2007)

3.2.6 Environmental Guidelines

The GoE, mainly through the EPA, has published a number of guidelines for the EIA process. These cover EIA procedures in general, the review of EIA documents, and specific sectors: irrigation and pesticides (EPA). Other relevant guidelines are those on roads (ERA 2001):

- EPA. 2000. EIA Guideline Document
- EPA. 2003. EIA Procedural Guideline Series 1
- EPA. 2003. Guidelines Series Documents for Reviewing Environmental Impact Study Reports (1: Guidelines for Review Approach; 2: Guidelines for Contents and Scopes of Report; 3: Checklist of Environmental Characteristics; 4: Review Criteria)
- EPA. 2004. Environmental Management Plan (EMP) for the Identified Sectoral Developments in the Ethiopian Sustainable Development and Poverty Reduction Programme (ESDPRP) (draft)
- EPA. 2004. EIA Guidelines on Irrigation, Crop Production, Fertilizer, Pesticides, Fisheries and Forestry.
- EPA. 2004. ESIA Guidelines on Dams and Reservoirs, Hydropower, Water Supply, and Livestock and Rangeland Management
- EPA. 2004. Guideline on Composting
- EPA. 2004. Technical Guidelines on Household Waste Management
- ERA. 2001. Environmental Procedures Manual

The ANRS government has published its own EIA guidelines based on the 2001 federal guideline, but simplified for easier use:

- EPLAUA. 2006. Simplified General Environmental Impact Assessment Guideline

3.3 Other National, Regional and Sectoral Strategies, Policies, Laws and Organisations

3.3.1 Water

3.3.1.1 Policies and Proclamations

Ethiopian Water Resources Management Policy is set out in Proclamation No. 197/2000 (the "WRM Proclamation"). The policy is intended to promote comprehensive and integrated water resources management and optimal utilisation of available water resources for sustainable socio-economic development. *Inter alia,* the policy calls for conservation and protection of water resources as an integral feature of the water resources planning and development process, and therefore mandatory EIAs of all water resource development projects (see Chapter 5 of the EPA's EIA Procedural Guidelines which cover water development for agriculture and hydropower, as well as associated resettlement).

The proclamation entrusts the Ministry of Water Resources (now MoWE) with broad powers to plan, manage, use, administer and protect water resources, including the promotion and implementation of irrigation projects.

The Policy was elaborated in the Ethiopian Water Sector Strategy 2002-2005 (2001), also known as the National Water Strategy. The purpose of the Strategy was to translate the Policy into action, with the following specific objectives:

- Improving the living standard and general socio-economic well being of the Ethiopian people.
- Realising food self-sufficiency and food security in the country.
- Extending water supply and sanitation coverage to large segments of the society, thus achieving improved environmental health conditions.
- Generating additional hydro-power.
- Enhancing the contribution of water resources in attaining national development priorities.
- Promoting the principles of integrated water resources management.

The Strategy was a comprehensive document, covering all aspects of water resources development and management. *Inter alia*, it called for mandatory EIAs for all water projects, and promotes gender mainstreaming (see Section 3.3.12). From an environmental point of view, it is interesting that the Strategy included a call to "Reclaim existing wetlands" by drainage and other means, but not for their conservation or the protection of wetland values.

MoWE sub-sectoral policies include Irrigation, Hydropower, and Water Supply and Sanitation, each with an associated Strategy.

In 2002 MoWR published the *Water Sector Development Programme* (WSDP) covering the period 2002-2016 (MoWR 2002). This defines concrete interventions in terms of projects and programmes to achieve the water policy objectives, using the guidelines set under the National Water Strategy. The WSDP is a development programme with a 15 year planning period from 2002-2016, divided into three five year development programmes:

- 2002 – 2006 short term
- 2007 – 2011 medium term
- 2012 – 2016 long term

Components of the WSDP include:

- Water Supply and Sanitation Development Programme
- Irrigation Development Programme
- Hydropower Development Programme
- Water Resource Development Programme
- Institutional Capacity Building Programme

Further details are available on the policy page of the Ministry's website:

http://www.mowr.gov.et/index.php?pagenum=2.4

3.3.1.2 Federal Institutions

The Ministry of Water Resources (MoWR) was established by Proclamation 256/2001 concerning Reorganisation of the Executive Organs of the Federal Democratic Republic of Ethiopia in relation to water management. Until 2010 the Ministry was responsible for the planning, management, utilisation and protection of water resources. In 2010 responsibility for energy was added to the Ministry's role and it was renamed the Ministry of Water and Energy (MoWE).

In terms of water resources allocation, important specific powers of MoWR, now MoWE, are to:

- Issue permits and certificates of Professional Competence;
- Ensure that studies relating to water resources development, protection, utilisation and control have been carried out;
- Determine the allocation and manner of use of water resources among various uses and users;
- Require submission of plans and proposals from any person who applies for a permit to undertake any kind of water works and approve, reject, or amend such plans and proposals;
- Issue directives regarding water use restrictions in situation of water shortage emergency and supervise implementation of the same.

The MoWE may delegate its power and duties to other appropriate bodies (such as ABA or other regional bodies) where this is necessary for efficient execution of its duties. However, the Water Resources Management Regulations do not delegate to the regions the power to issue water use/wastewater discharge permits within their respective regions. The MoWE retains the mandate to issue permits for most of the country's water resources, although this can be delegated. This is also true for the collection of fees and water use charges. Therefore, waterworks developed by the regional states would see their fee collection performed by the MoWE. Furthermore, tariff rates are determined for different water uses at national level, without the intervention of regional states.

The Ministry has a number of Directorates, including an Irrigation and Drainage Directorate, each with an environmental team.

Other important water-related federal organisations are:

- The Water Works Design and Supervision Enterprise (WWDSE), established by Regulation 42/1998 as amended by 110/2004 and governed by the Public Enterprises Proclamation 25/1992, conducts studies regarding hydraulics and water works;
- The Ethiopian Water Works Construction Enterprise (WWCE), established by Council of Ministers' Regulation No. 156/1994, engages in the construction of water works;
- The Water Resources Development Fund (WRDF), established pursuant to Proclamation 268/2002, enables institutions engaged in the provision of water supply and sanitation services to be fully self sufficient;
- The future Abbay Basin Authority (ABA) based on Proclamation No. 534/2007 concerning the establishment of River Basin High Councils and Authorities, will promote and monitor the integrated water resources management process in the Abbay Basin.

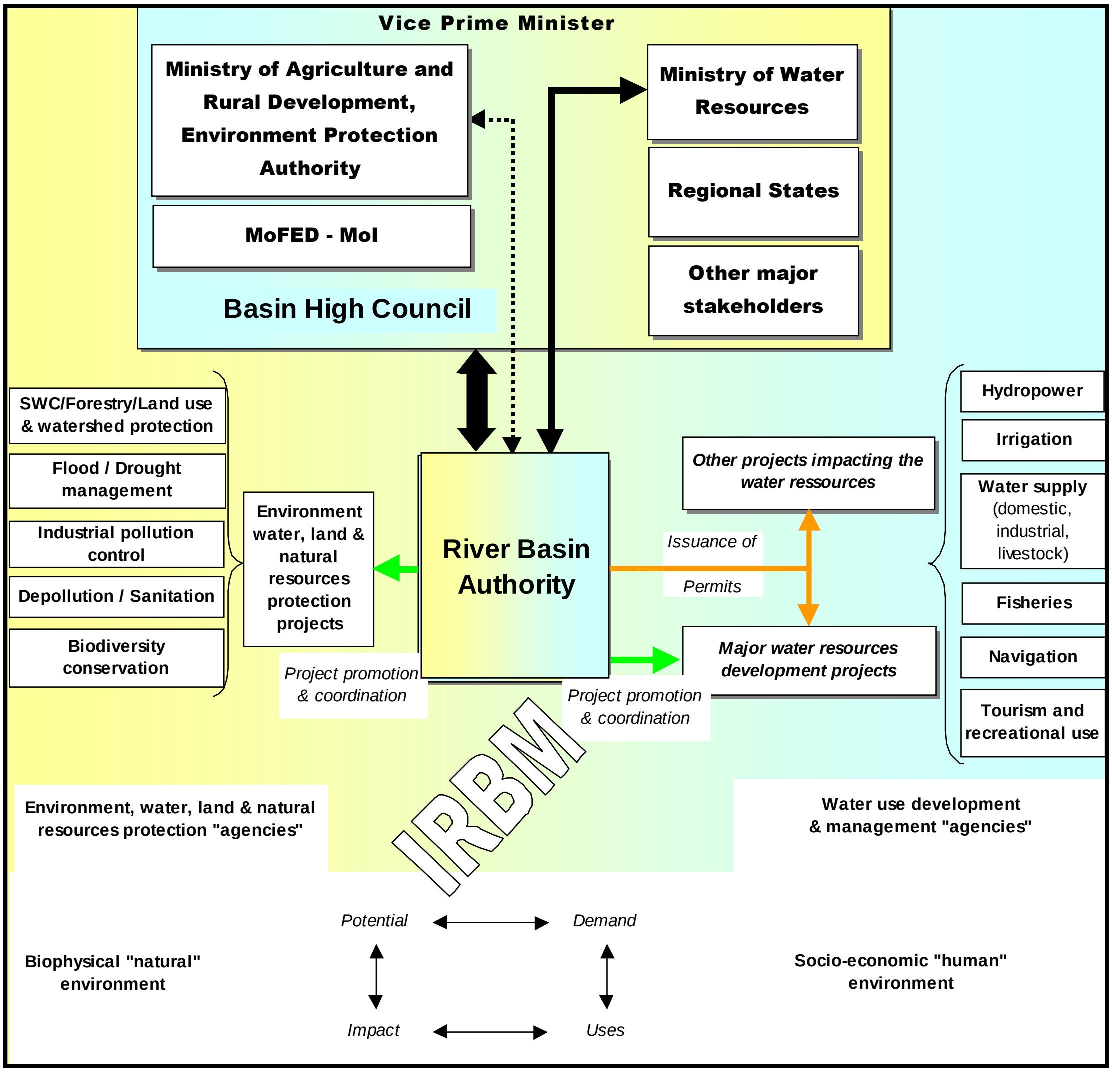
3.3.1.3 ABA

River Basin Organisations (RBO) around the world are of very variable form and scope and may be assigned very different duties. In Ethiopia, after a detailed process of consultation and discussion with stakeholders during the "Institutional Set-up Studies of the Abbay Basin Project" (2004-2007: see BRLi & T&A 2008), a format for RBOs was adopted and subsequently legislated by the River Basin Councils and Authorities Proclamation (No. 534/2007).

Ethiopian RBOs will have both a High Council and a River Basin Authority with specified duties and accountability, and may be set up in a total of 12 river basins in the country, through specific regulations, when deemed relevant. Regulation 151/2008, providing for the establishment of the Abbay Basin High Council and Abbay Basin Authority (ABA, also sometimes quoted as the Abbay River Basin Authority), was gazetted on 12 May 2008. ABA is responsible for undertaking and facilitating the implementation of integrated water resources management in the basin, which includes the preparation and submission of the River Basin Plan to the High Council and monitoring of its implementation.

The "Institutional Set-up Studies of the Abbay Basin Project" recommended a structure and duties for the Abbay Basin High Council and Abbay Basin Authority as shown in Figure 3-2.

Figure 3-2: Abbay River Basin - Organisational Features recommended by Institutional Set-up Study



Source: BRLi & T&A (2008)

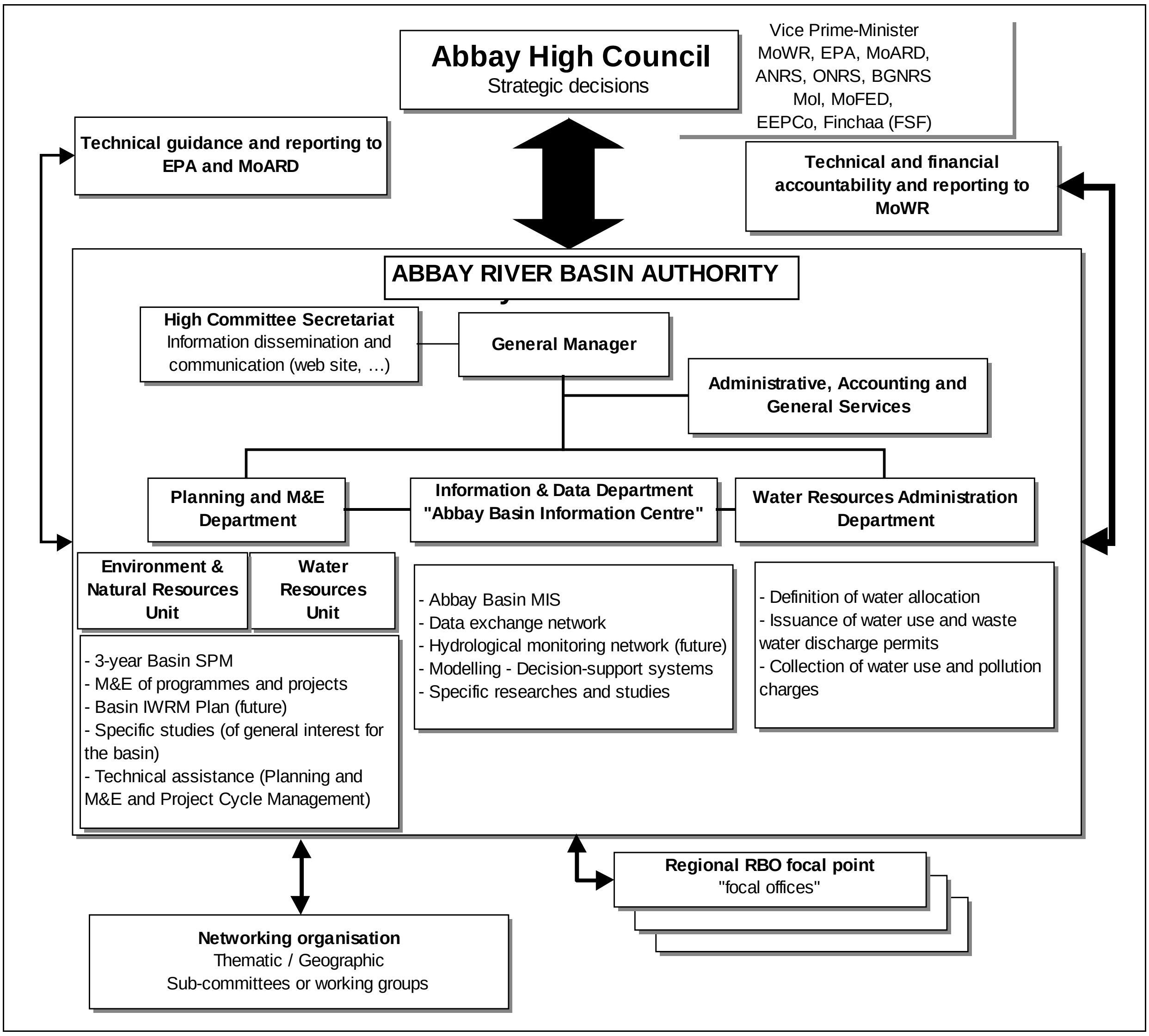
The water resources planning and administration activities refer to mandates and duties as defined by Proclamation No. 534/2007 and assigned to River Basin Authorities and related High Councils. These responsibilities are:

- **The High Council**
  1. Policy guidance and planning;
  2. Direct the preparation of River Basin Plan;
  3. Propose to the Government the rate for water charges;
  4. Examine and pronounce on the appropriateness of prioritising and building major water works;
  5. Examine and decide on water allocation rules and principles;
  6. Manage water use disputes between stakeholders;
  7. Provide information to the concerned bodies in charge of discussing with neighbouring countries;
  8. Establish ad hoc or standing committees.
- **The River Basin Authority**
  1. Initiate and submit to the Basin High Council policy measures needed to create a conducive climate for the implementation an Integrated Water Resources Management process within the Basin; and follow up the implementation of those measures which are approved;
  2. Undertake activities necessary for, and facilitate the implementation of Integrated Water Resources Management in the basin;
  3. Ensure that projects, activities and interventions related to water in the basin are, in their content, schedule, impacts, management are in line with the Integrated Water Resources Management process;

4. Prepare and submit to the High Council the River Basin Plan, and monitor its implementation upon approval;
5. Without prejudice to the power given to Regional States, issue permits for water uses and water works and ensure the terms of the permits are complied with;
6. Collect, compile, analyse and disseminate information for proper planning, steering and administration of water resources in the basin;
7. Develop and use a river basin model in order to guide and support its water resources strategic planning and water administration functions;
8. Give advise and technical support to the Basin High Council and the MoWE on dispute resolution in relation with allocation and use of water resources in the basin;
9. Set up a forum for effective networking among stakeholders;
10. Collect water charges from users;
11. Prepare and provide necessary information for concerned bodies in charge of discussions with other countries concerning international transboundary river basins upon request of the Basin High Council;
12. Undertake study, survey or investigation that is deemed necessary to carry out its functions;
13. Own property, enter into contracts, sue and be sued in its own name; and
14. Carry out other functions helpful for the implementation of its objectives.

These roles and responsibilities are summarised in structural terms in Figure 3-3.

Figure 3-3: Abbay River Basin Institutions - Organisational Chart and Duties



Source: BRLi & T&A (2008)

3.3.1.4 Tana and Beles Sub-Basin Organisations (TaSBO and BeSBO)

The geographical areas under consideration are specific sub-basins of Lake Tana and the Beles River, and specific arrangements must be proposed for these two sub-basins, separately or together.

There is now a wide consensus on the need to create, as soon as possible, a specific Tana Sub-Basin Organisation (TaSBO) and its sister Beles Sub-Basin Organisation (BeSBO) able to address the significant challenges in the area (see above). The exact shape and form of these organisations, their relationship with and links to other institutions, and the timeframe for their establishment, remain to be resolved. A TaSBO office has been created in Bahir Dar, but the legal status of the organisation has not been determined yet.

3.3.1.5 Regional Institutions

The Amhara Bureau of Water Resources Development (BoWRD) was first established in 1995, and its powers and duties redefined by proclamation No. 120/2006. It is responsible for water resources management within the Region, with the following specific powers:

- Ensure and supervise that laws, regulations and directives issued by the federal and regional states concerning water resources management are observed;
- Supervise the balanced distribution and utilisation of the Region’s water resources among various types of services;
- Cause the implementation of meteorological and hydrological data for development activities by gathering them from relevant bodies and analysing and distributing the same;
- Provide necessary support relating to the conservation of the water resources, in particular, concerning cross-region water bodies and activities undertaken by Federal organs in the region…

The Amhara Water Works Construction Enterprise (AWWCE) was established by the Amhara National Regional State Proclamation No. 15/1996. Its duties are similar to the federal Water Works Construction Enterprise, at a regional level.

In 1997, the quasi-NGO Organisation for Relief and Development in Amhara (ORDA) shifted its strategy from relief to development. The organisation has seven areas of intervention, including the water sector.

3.3.1.6 Water Users Associations

Article 27(2) states of the WRM Proclamation states that Water Users Associations (WUAs) may be established upon the initiation and will of the users. Article 27(1) of the Proclamation allows the MoWR (described as the "Supervising body" in the proclamation) to encourage the establishment of Associations of Water Users Associations (AWUAs), in consultation with appropriate public bodies "as it deems necessary to utilise water for beneficial uses".

The WRM Proclamation is framework legislation, requiring elaboration by means of regulations and directives. Some regulations have already been adopted pursuant to Article 27 of the WRM Proclamation. These are contained in Council of Ministers Regulations No. 115/2005 Ethiopian Water Resources Management Regulations (the "WRM Regulations"). Article 28 of the Regulations provides that water resource permit holders as well as those exempted from holding such a permit may establish "water users' cooperatives societies" in accordance with the Cooperative Societies Proclamation No. 1471/1998 (the "Cooperatives Proclamation"). Article 29 (1 and 2) regarding registration appears to be designed to apply specifically to irrigation water users. Its two sub-articles state that cooperative societies established to undertake medium or large scale irrigation shall be registered by the Ministry, and those that undertake small scale irrigation shall registered by “an organ established by law at regional or city administration level to organize and register cooperatives".

MoWE has drafted an AWUA national proclamation and its related legal instruments. The AWUA proclamation incorporates lessons from Ethiopia's rich history of traditional irrigation management by institutions such as *ye wuha abat* (BRLi 2009a) and is now undergoing parliamentary processes.

3.3.1.7 International Institutions

As mentioned, the Nile Basin Initiative (NBI) is a partnership initiated and led by the riparian states of the Nile River through the Council of Ministers of Water Affairs of the Nile Basin states (Nile Council of Ministers, or NILE-COM). The NBI seeks to develop the river in a cooperative manner, share substantial socio-economic benefits, and promote regional peace and security.

In its current form, NBI is a transitional process towards a future Commission, pending on the ratification of the Cooperative Framework Agreement (CFA) by the NBI member States. Apart from ABA, NBI (to be replaced by the future Commission) is the key stakeholder responsible for managing and mitigating any transboundary cumulative effects relating to changes in water volumes and availability resulting from developments around Lake Tana and elsewhere along the Blue Nile. The current form of the CFA (already signed by 5 countries, but not ratified yet), states for instance that:

- **Article 4 – Equitable and reasonable utilization**

1. Nile Basin States shall in their respective territories utilize the water resources of the Nile River system and the Nile River Basin in an equitable and reasonable manner. In particular, those water resources shall be used and developed by Nile Basin States with a view to attaining optimal and sustainable utilization thereof and benefits therefrom, taking into account the interests of the Basin States concerned, consistent with adequate protection of those water resources. Each Basin State is entitled to an equitable and reasonable share in the beneficial uses of the water resources of the Nile River system and the Nile River Basin.
2. In ensuring that their utilization of Nile River system water resources is equitable and reasonable, Nile Basin States shall take into account all relevant factors and circumstances, including but not limited to the following:
   a. Geographic, hydrographic, hydrological, climatic, ecological and other factors of a natural character.
   b. The social and economic needs of the Basin States concerned;
   c. The population dependent on the water resources in each Basin State;
   d. The effects of the use or uses of the water resources in one Basin State on other Basin States;
   e. Existing and potential uses of the water resources;
   f. Conservation, protection, development and economy of use of the water resources and the costs of measures taken to that effect;
   g. The availability of alternatives, of comparable value, to a particular planned or existing use;
   h. The contribution of each Basin State to the waters of the Nile River system;
   i. The extent and proportion of the drainage area in the territory of each Basin State.
3. In the application of paragraphs 1 and 2 above, the Nile Basin States concerned shall, when the need arises, enter into consultations in a spirit of cooperation.
4. The weight to be given to each factor is to be determined by its importance in comparison with that of other relevant factors. In determining what is a reasonable and equitable use, all relevant factors are to be considered together and a conclusion reached on the basis of the whole.
5. Nile Basin States shall, in their respective territories, according to their national laws and regulations, keep the status of their water utilization under review in light of substantial changes in relevant factors and circumstances.
6. Nile Basin States shall observe the rules and procedures established by the Nile River Basin Commission for the effective implementation of equitable and reasonable utilization.

- **Article 5 – Obligation not to cause significant harm**

1. Nile Basin States shall, in utilizing Nile River System water resources in their territories, take all appropriate measures to prevent the causing of significant harm to other Basin States.
2. Where significant harm nevertheless is caused to another Nile Basin State, the States, whose use causes such harm shall, in the absence of agreement to such use, take all appropriate measures, having due regard to the provisions of Article 4 above, in consultation with the affected State, to eliminate or mitigate such harm and, where appropriate, to discuss the question of compensation.

These two articles clearly define a number of responsibilities of the member States with respect to the other NBI riparian States although, pending ratification of the CFA, the further procedures remain unclear. This ESIA has identified a number of transboundary impacts which will result from the Megech project, especially when combined with other water resource developments in the Lake Tana Sub-Basin (see Sections 6.5 and 6.7 in Chapter 6 of this report). In the current context of a transitional NBI, the authority responsible for the MPIDP should inform MoWE's Boundary & Transboundary River Affairs' Directorate about these impacts, and the Directorate should then itself notify NBI and its Blue Nile branch, ENTRO.

3.3.2 Land

3.3.2.1 Land Tenure

As stated in the MPIDP FS, the Rural Land Administration and Land Use Proclamation (Proclamation No. 456/2005) defines the state ownership of rural land and the tenure rights of the land occupant, including rights to "property produced on his land", rights of inter-generational tenure transfer, and rights of exchange land and limited leasing rights. Provisions are made for the registration and certification of tenure rights. Part Three of the Proclamation presents regulations relating to the use of rural land, particularly as it relates to soil and water conservation and watershed management. The rural land administration and land use laws are to be implemented by the regional states.

Land holding right gives the right to use the land for agricultural purposes as well as to lease it and, while the right remains in effect, bequeath it to family members, as well as the right to acquire property thereon, by labour or capital, and to sell, exchange and bequeath the same. The Proclamation also addresses environmental concerns, including non-compliance with directives on environmental protection.

An important feature of this Proclamation is that it stipulates rural land use and restrictions based on proper land use planning, providing for the proper use of various types of land, such as slopes, gullies and wetlands, as well as the utilization of rural land for villages and social services. In addition, it is envisaged that the Proclamation will create a sense of ownership among the vast majority of the rural population and enable them to take initiatives and collectively engage in environmental management activities.

As stated in the MPIDP FS, in line with the national proclamation, ANRS issued the regional Rural Land Administration and Use Proclamation (Proclamation No. 133/2006) in May 2006. The Proclamation established various articles with respect to rural land administration and use in the region. Included among the important points are the following: right to land holding, land re-distribution, land holding procedures, and minimum land holding and conditions leading to deprivation of holding rights. A number of articles are awaiting specific regulation towards implementation of legislation. Based on information from the regional land administration office, farmers in the project woreda have already been issued Class I land use certificates.

The regional proclamation has been amplified by Council of Regional Government Regulations No. 51/2007 The Revised Amhara National Regional State Rural Land Administration and Land Use System Implementation Regulations.

3.3.2.2 Land Acquisition and Redistribution

Land acquisition and compensation is covered by Proclamation No. 455/2005 Expropriation of Landholdings for Public Purposes and Payment of Compensation. Regulations under the proclamation include Council of Ministers' Regulations No. 135/2007 Payment of Compensation for Property Situated on Landholdings Expropriated for Public Use.

At regional level the relevant procedures and guidance are:

- ANRS. 2007. *Directive on Redistribution of Land in Modern Irrigation. EPLAUA.*
- ANRS. 2009. *Guideline on Expropriation of Landholdings for Public Purposes and Payment of Compensation. EPLAUA.*

3.3.3 Agriculture and Rural Development

3.3.3.1 *Agricultural Development-Led Industrialisation*

Distinctive features of the 1995 Agricultural Development-Led Industrialisation strategy (ADLI) include:

- commercialization of smallholder agriculture through product diversification;
- a shift to higher-valued crops;
- promotion of niche high-value export crops;
- support for the development of large-scale commercial agriculture;
- effective integration of farmers with domestic and external markets; and
- tailoring interventions to address the specific needs of the country's varied agro-ecological zones.

The strategy promotes the use of labour-intensive methods to increase output and productivity by applying chemical inputs, diversifying production, utilizing improved agricultural technologies. ADLI also emphasizes the importance of distinguishing agro-ecological zones and tailors strategies as well as interventions for optimal development outcomes. This distinction guides the differentiated interventions needed to promote cross-sectoral and integrated growth (ECOSOC analysis)[38].

3.3.3.2 *Agricultural and Rural Development Policies and Strategies*

- The 2002 Agricultural Rural Development Policies and Strategies (ARDPS) is an overarching policy and strategic framework, anchored on the ADLI and incorporating the following main principles: efficient use of human resources, prudent allocation and use of land resources, agricultural development in line with agro-ecology, encouraging specialisation, diversification and commercialisation of agricultural production, integration with other sectors, and improving agricultural marketing. It is intended to improve rural land administration and reduce drought vulnerability.
- GoE has developed a Food Security Strategy intended to increase food supplies and access to food and to strengthen the country's emergency response capability. The strategy promotes participatory development and social mobilisation and improved social safety nets, and amongst other features provides for environmental protection, management and rehabilitation.
- The GoE is undergoing a process within the Comprehensive Africa Agriculture Development Programme (CAADP) framework to accelerate its rural and agricultural development agenda, including a review of policies and gap analysis.
- The GoE is also developing a Policy and Investment Framework (PIF) for agricultural growth, with donor support.

3.3.4 Pesticides

Pesticides are administered under the Pesticide Registration and Control Council of State Special Decree No. 20/1990. Under the decree a Pesticide Registration Council has been established. This registers pesticides and issues provisional permits for importation and use of non-registered pesticides, especially for use in the new floriculture industry.

An inter-agency National Pesticide Advisory Committee has been established to advise MoARD on implementation of the Special Decree.

There is no national policy on Integrated Pest Management (IPM) or on Integrated Vector Management (IVM, the livestock husbandry equivalent of IPM) or on organic agriculture. An IPM Working Group was active in Amhara Region but is no longer functioning due to lack of funds (see Annex 8).

3.3.5 Waste

Solid waste is covered by the Solid Waste Management Proclamation (513/2007). The aim of the proclamation is to enhance capacities at all levels to avoid adverse impacts from solid waste disposal and to create economically and socially beneficial assets out of solid waste. The proclamation focuses on urban administrations and requires them to develop solid waste management plans. It also covers the development and management of solid waste disposal sites. Rural areas generate little solid waste and are not covered in any detail by this proclamation.

[38] Source: http://webapps01.un.org/nvp/frontend!policy.action?id=124&tab=analysis

3.3.6 Biodiversity, Wildlife and Wetlands

Biodiversity: as stated in the MPIDP FS, the National Biodiversity Policy (NBP) was established in 1998 based on a holistic ecosystem approach to conserve, develop and utilize the country's biodiversity resources. Integration of biodiversity conservation and development in federal and regional sectoral development initiatives, and mobilization of international cooperation and assistance, have been identified as the principal strategies for implementation of the policy.

The policy provides for guidance towards effective conservation, rational development and sustainable utilization of the country's biodiversity, and contains comprehensive policy provisions for the conservation and sustainable utilization of biodiversity. Protection of biodiversity-related traditional indigenous knowledge and communities' benefit sharing arrangements are not yet effective. Similarly, the potential of biodiversity-related opportunities has not yet been exploited to enhance sustainable livelihood to the desired level. However, there is a general understanding with respect to changing the management approach in order to bring about the desired benefits.

More recently GoE has developed a National Biodiversity Strategy and Action Plan (NBSAP: GoE 2005) as a required action under the Convention on Biological Diversity. The NBSAP integrates biodiversity conservation into agricultural, wildlife and forestry policies at National and Regional (i.e. regions within the country) levels, and guides the development of draft agricultural, forestry, and wildlife policies as deemed necessary. It also tries to ensure that reforms in the forestry sector are integrated with reforms in the wildlife sector and the new forestry laws are also framed fully within the context of the CBD and other International Conventions such as CITES (GoE 2006a).

Ethiopia has signed and ratified the Convention on Biological Diversity and the International Treaty on Plant Genetic Resources for Food and Agriculture. National legislation on traditional knowledge to enact the Convention includes:

- Access to Genetic Resources and Community Knowledge, and Community Rights Proclamation, No. 482/2006.

A National Policy for Plant Genetic Resources Conservation and Development has been formulated based on the rationale that the conservation of PGRFA is one of the bases for overall socio-economic development and sound environmental management. The main objectives of the National Policy for Plant Genetic Resources Conservation and Development are to: ensure that Ethiopian plant genetic resources are conserved, developed, managed, and sustainably used; assert national sovereignty over genetic resources, and develop mechanisms that will ensure the effective control of movement and management of genetic resources; build scientific capacities in order to explore, collect, assess, study, systematize, introduce, improve, manage and sustainably use biological resources; develop capacities for the improvement, generation, development and sustainable use of biotechnology and its transfer; integrate programmes for PGRFA conservation and development into national and regional development strategies and plans; recognise, foster and augment the traditional methods and the knowledge of local communities relevant to the conservation, development and sustainable use of PGR; and encourage the participation and support of local communities in PGR conservation and development, and ensure that farmers/communities share the benefits accrued as a result of using indigenous germplasm; create a functional and efficient organizational structure and inter-institutional linkage to facilitate cooperative action and coordination PGR conservation and development; promote international and regional cooperation in PGR conservation and development (IBC 2008).

According to the EPA's website (accessed 05.05.2010), the major areas where in situ crop conservation is being carried out are Bonga, Bale, East Shewa, South Wello and Tigray. In order to prevent the extinction of useful plants and crops, 56,558 samples of various species, mostly crops, are being conserved ex-situ in the Gene Bank at the Institute for Biodiversity Conservation and Research.

Wildlife and Protected Areas: after a number of organisational re-structurings, wildlife and protected areas are now the responsibility of the Ethiopian Wildlife Conservation Authority (EWCA) which was established recently, pursuant to Proclamation No. 575/2008 on "Establishment of the Ethiopian Wildlife and Development Authority". The Authority reports to the Ministry of Culture and Tourism. The guiding legislation is:

- The Wildlife Development, Conservation and Utilisation Proclamation, No. 541/2007.

This legislation builds on the 2005 Wildlife Policy and Strategy. The 2007 Proclamation has four parts and twenty articles. The Policy on which it is based has five main elements: wildlife resources development, protection and administration of protected areas; conservation of endemic and threatened wildlife; wildlife resources utilization which enables the country in promoting ecotourism and marketing of wildlife resources; encouraging investors especially private ones to participate in the conservation of wildlife; strengthening research, education and training on wildlife, establishing a network to compile and disseminate information to national and international users[39]. The Proclamation is supported by regulations issued in 2008:

- Wildlife Development, Conservation and Utilisation Council of Ministers Regulations, No. 163/2008.

At present EWCA is supported by a UNDP-GEF project: Sustainable Development of the Protected Area System of Ethiopia (SDPASE), implemented by GTZ-IS.

Wetlands: at present, Ethiopia does not have a formal, coordinated policy with respect to wetlands. As stated in the MPIDP FS, wetlands are considered among the most productive type of ecosystem in the world, providing benefits far in excess of those obtained from alternative uses to which they are subjected. Ethiopia is endowed with vast wetlands, including a tract in the project area; however, efforts towards their conservation and sustainable utilisation are very limited, and no clear policy and legislative framework have been designed. The Environmental Protection Authority (EPA) and Ethiopian Wildlife & Natural History Society (EWNHS), in collaboration with Ramsar Bureau and other funding organizations, are focusing efforts in this direction, and have conducted successful workshops and awareness raising programs. To date, Ethiopia has not signed the Ramsar Convention (see Section 3.5.1). As noted, the Water Sector Strategy calls for the reclamation rather than the conservation of wetlands.

3.3.7 Forests

The Forestry Conservation, Development and Utilisation Proclamation (Proc. No. 94/1994) includes provisions aimed to ensure the conservation of existing forests and the establishment of State Forests. One of the objectives for the establishment of State Forests is to conserve forest resources within their ecosystems. The law prohibits the felling of *Hagenia abyssinica*, *Cordia Africana*, *Podocarpus gracilior*, *Juniperus procera*, and *Olea europaea* ssp. *cuspidata*) from their natural habitats.

In July 2004, a Centre for Indigenous Trees Propagation and Biodiversity Development was established, with a view to conserving *Hagenia abyssinica*, *Podocarpus falcatus*, and many other endangered Ethiopian trees. Located approximately 50 km west of Addis Ababa, the Centre's objectives are to fight against biodiversity loss at the genetic, species and ecosystem levels, and to increase the capacity to provide timely, innovative and practical solutions to conservation problems (Vivero *et al.* 2005).

3.3.8 Fish and Fisheries

Fish and fisheries fall under the Ministry of Agriculture and Rural Development by virtue of this ministry's responsibility for wildlife in its enabling legislation. In 2003 MoARD issued a *Proclamation on Fisheries Development and Utilisation* (Proc. No. 315/2003). This establishes a requirement that person undertaking commercial fishing or aquaculture should first obtain a permit. In addition, it establishes a requirement for a permit for subsistence fishing in national parks or fishery reserved areas, for fishery research, and for the transfer of fish between different water bodies.

The Proclamation envisages that laws on fisheries will be enacted by others (i.e. the Regional States). It states that any fisheries law that may be issued pursuant to it shall make clear stipulations about protected fishery areas, annual fish catch, types and number of fishing gears, fishing seasons, procedures for issuing, renewal and suspension of fishing license, fish transfer, aquaculture fish trade, safety and quality standards of fish products, prohibited activities, community participation, environmental impact assessment and other related matters.

It is understood that a Fish Quality Assurance Regulation is under development at national level, which would include the establishment of a Fishery Authority.

Aquaculture has now been established as a national priority under MoARD's 2009 National Aquaculture Development Strategy for Ethiopia.

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39 Bezawit Eshetu in UNEP's e-newsletter Addis Ababa Highlights, Vol. 5, No. 5, May 2008.

According to Gordon *et al.* (2007), in 2003 the ANRS government issued a regional Fisheries Development, Protection and Utilisation Proclamation No. 92/2003. This covers the same areas as the national policy, but with the additional objective of creating employment opportunities in fishing communities. It also states that information, including research findings, should be made available to fishing communities. As with the national proclamation, the regional proclamation focuses heavily on regulatory measures and inspectors. It does not mention co-management.

In 2007 the ANRS Parliament approved the Fisheries Resource Development, Protection and Utilisation Proclamation Enforcement of Regional Government Council Regulation No. 50/2007. Under this, the BoARD is mandated to control and properly manage the fishery and aquaculture sector. The next step is to develop management plans for each water body. There could be many methods available for the management of fisheries, including the use of closed seasons, closed areas, limitation of catches or fishing effort, property rights, taxation, catch quotas and mesh size regulation. Usually, a management regime comprises a mixture of all of these methods.

ANRS BoARD has initiated regulation of fisheries by drafting application and permit forms for commercial, sports and fishing for research purposes and identity cards for those who hold permits (BRLi & T&A 2008). It has also drafted two directives which it is understood will be approved very soon and will form the practical legal basis for a significant programme of fisheries management and enforcement at kebele level (Eshete Dejen, pers. comm.):

- Directive for Providing Fishing Licence.
- Directive for Assignment of Fish Inspectors.

3.3.9 Labour

The principal source of labour law in Ethiopia is Labour Proclamation No. 377/2003. This covers standard topics such as freedom of association and the right to collective bargaining and to strike, and brings the legal code closer to international norms, based on the ILO's Freedom of Association and Protection of the Right to Organise Convention of 1948 (No. 87). *Inter alia*, the proclamation establishes a normal working week of 48 hours with one day of rest, normally Sunday, overtime rates, paid leave, the 12 national public holidays, and maternity leave.

Under Article 89, the statutory minimum age for young workers is 14 years, and young workers may be protected by special measures (in 1999 ILO found that some 54% of all children in Ethiopia between the ages of 10 and 14 were working).

The proclamation does not establish a minimum wage.

At the national level, workers are represented by the Confederation of Trade Unions (CETU) with a claimed membership of 9 Federations and some 431 basic unions[40].

The responsible government ministry is the Ministry of Labour and Social Affairs (MoLSA), with Bureaus of Labour and Social Affairs (BoLSA) at regional level, with corresponding offices at zonal, woreda and (in theory) kebele level.

Occupational health and safety is governed by the Occupational Safety and Health Directive (2008). This is also administered by MoLSA, which has an Occupational Safety, Health and Working Environment Department (OSHWED).

The Labour Proclamation (377/2003) made provision for the establishment of a Tripartite Labour Advisory Board, with responsibility for studying and examining matters concerning employment service, working conditions, the safety and health of workers, labour laws in general and giving advice to the Minister, but its activities are constrained due to lack of resources.

3.3.10 Poverty

GoE has developed and implemented a number of strategies and programmes to end poverty and meet the Millennium Development Goals (MDGs). These include:

- Poverty Reduction Strategy Programme (PRSP) 2002
- Sustainable Development and Poverty Reduction Programme (SDPRP) 2002-2005
- A Plan for Accelerated and Sustained Development to End Poverty (PASDEP) 2005/06-2009/10 (GoE 2006b).

[40] Information from ILO website, http://www.ilo.org/public/english/dialogue/ifpdial/info/national/eth.htm

- Growth and Transformation Plan (GTP). This is the latest strategic development plan, covering the period 2010-2015 and intended to lay a platform for transforming the country's economy from an agricultural base towards industrialisation.

All these programmes promote infrastructure, human resource development, rural development, food security and capacity building. The PASDEP increased emphasis on the commercialisation of agriculture, enhancing industries and achieving the MDGs.

Under the Productive Safety Net Programme (PSNP) launched by the Ethiopian government in 2005, people receive cash and food in exchange for work. Tasks focus on improving public facilities, such as roads, water points, and health and education posts.

3.3.11 Resettlement

Involuntary resettlement (compulsory acquisition of land and assets and related impacts) is governed by Proclamation 455/2005 "Expropriation of Landholdings for Public Purposes and Payment of Compensation Proclamation". This proclamation is intended to address the shortcomings of earlier resettlement programmes which resulted in many cases of impoverishment, family disintegration and marginalization (ERM 2007).

A detailed discussion of relevant laws covering Public domain, Entitlement, Property laws, Land asset classification and valuation, Customary laws, Procedures for expropriation, and Procedures for grievance redress is given in ENIDP's Resettlement Policy Framework (ERM 2007). This discussion includes a comparison of GoE policy and laws with Bank policy.

Further analysis will be presented in the forthcoming reports of the MPIDP's Resettlement Action Plan (RAP) consultant.

3.3.12 Gender & Women

The GoE has taken active steps to promote the welfare and role of women in Ethiopian society, commencing with the National Policy on Ethiopian Women (NPEW), 1993, and reinforcing this with the gender equality provisions of the Constitution (1995).

The Women's Policy aimed to institutionalise the political, economical, and social rights of women, largely by creating appropriate structures in government organisations to ensure that public policies and interventions are gender-sensitive.

Consistent with this policy, Article 25 of the Constitution of the FDRE guarantees all persons equality before the law, and prohibits discrimination on grounds of gender. In addition, Article 35 reiterates the principles of equality in access to economic opportunities, including the right to equality in employment and in land ownership.

Within the water sector, the 1999 Ethiopian Water Resources Management Policy includes an article (Article 2.2.10) on Gender Issues:

- "Promote the full involvement of women in the planning, implementation, decision-making and training as well as empower them to play a leading role in self-reliance initiatives."

This policy requirement was elaborated in the 2001 Ethiopian Water Sector Strategy (Box 3-1).

Guidelines on gender specific to MoWE include:

- MoWR. 2001. *Gender Mainstreaming Guidelines and Checklists for the Water Sector.*
- MoWR. 2005. *Gender Mainstreaming Field Manual for Water Supply and Sanitation Projects, 2005.*

The administrative machinery includes a Women's Affairs Office (WAO) in the Office of Prime Minister, with Women's Affairs Departments in each line ministry, Bureaus in the regions, and Offices at woreda level. In ANRS the responsible office is termed the Women, Children and Youth Affairs Bureau.

To maximise their effectiveness, these offices work closely with civil society organisations (NGOs). However, the recent (2009) Proclamation for the Registration and Regulation of Charities and Societies restricts promoting equality, including gender equality, to NGOs classified as Ethiopian, i.e. those which obtain no more than 10% of their funds from external sources. This has had a major impact on organisations using advocacy to promote the development of civil society including women's rights in Ethiopia.

Box 3-1: Extract on Gender Mainstreaming from Ethiopian Water Sector Strategy

Section 4.1.8 Gender Mainstreaming

1. Ensure that gender issues are incorporated in the process of planning & implementation of water resources management.
    a) Involve women in the development and management of water resources and small-scale irrigation activities. Provide women with opportunities to play leadership roles in community based development structures
    b) Stimulate women to participate in water resources management activities to ensure continuity in service delivery and thereby sustainability. Sensitize and encourage women to participate in the management of water schemes
    c) Enable women to have influential roles in decision-making. Moreover, assist women, to get out of the crushing workload of fetching and carrying water for family use.
2. Improve situations where women can easily access to water and sanitation facilities to reduce the impact of poor environmental sanitation of their health. Educate women on water, sanitation and health situations so that those community health situations can improve.
3. Enhance the operation and maintenance capacity of women through technical and systems management training services. Improve the enabling environment for women to play influential roles in water sector management.
4. Develop mechanisms to deal with situations those hinder women from playing important roles in management of water sector development systems.

3.3.13 Health

As stated in the MPIDP FS, Ethiopia in general, and ANRS in particular, has a low level of health, even in comparison with other Sub-Saharan countries. This is largely related to low levels of income and widespread poverty, low levels of education, nutritional deficiencies, poor environmental conditions, and inadequate access to health services. The government has therefore assigned a very high priority to significantly improving health care and, in 1998, issued a Health Policy based on the following main principles:

- Democratisation and decentralisation of the health care system.
- Promotion of disease preventive components.
- Ensuring accessibility to health care for the whole population.
- Development of appropriate capacity based on needs assessment.
- Promotion of private sector and NGO participation in the provision of health care.
- Promotion and strengthening of inter-sectoral activities through a national self-reliance program.

Strategies and programmes have been designed to implement the stated health principles within a defined period of time. The strategies include raising the awareness of personal and environmental health care and sanitation through information, education and communication (IEC); control of disease; and promotion of primary health care through community participation. The relevant proclamation is:

- Public Health Proclamation No. 200, 2000.

A link to control of zoonoses (diseases carried by animals which may affect humans) is provided by:

- Animal Diseases Prevention and Control Proclamation No. 267, 2002.

Of relevance to the project, the Ministry of Health is implementing a strategic plan for improving access to basic water supplies and to sanitation termed the Universal Access Plan (UAP). The implementation strategy of the UAP includes:

- Involvement of the civil society in all aspects;
- Community management scaling up;
- Focus on appropriate technology;
- Integrated and harmonised water, sanitation and hygiene (WASH) programme
- Implementation (no parallel programmes),
- Local manufacturing and standardisation; and
- Woreda empowerment through institutional capacity building.

3.3.14 Cultural Heritage

Following approval of the 1997 Cultural Policy[41], in Ethiopia cultural heritage is administered through:

- A Proclamation to Provide for Research and Conservation of Cultural Heritage, No. 209, 2000.

This proclamation includes and supersedes the two previous proclamations (No. 229 of 1966 and No. 36 of 1989), and establishes the Authority for Research and Conservation of Cultural Heritage (ARCCH) as the responsible federal body. It also defines and categorises cultural heritage, deals with cultural heritage management, and includes provisions for the exploration, discovery and study of cultural heritage.

For proposed projects, "Impact", according to the EIA Proclamation (No. 299, 2002), is "any change to the environment or to its component that may affect human health or safety, flora, fauna … **natural or cultural heritage**, other physical structure, …" (emphasis added by ESIA editor).

The exact wording of the important article on **chance discoveries** in Proclamation No. 209, 2000 is given in Box 3-2 (below).

The cultural heritage authority, ARCCH, has its headquarters in Addis Ababa, and is the responsibility of the Ministry of Information and Culture.

At regional, zonal and woreda (district) levels, heritage issues are managed and administered by the respective Bureaus of Culture and Tourism.

Other important national institutions with heritage interests include the National Museum, Addis Ababa University's Institute of Ethiopian Studies, History Department, and School of Architecture, the Ethiopian Orthodox Church, and other religious organisations.

Key international organisations with Ethiopian representation are the International Council on Monuments and Sites (ICOMOS), and UNESCO. Ethiopia is a party to the UNESCO World Heritage Convention and the UNESCO Convention for the Safeguarding of Intangible Cultural Heritage.

Box 3-2: Extract on Chance Discoveries from Proclamation 209, 2000

Article 41. Fortuitous Discovery of Cultural Heritage

1. Any person who discovers any cultural heritage in the course of and excavation connected with mining explorations, building work, road construction or other similar activities or in the course of any other fortuitous event, shall forthwith report same to the Authority (ARCCH), and shall protect and keep same intact, until the Authority takes delivery thereof.
2. The Authority shall, upon receipt of a report submitted pursuant to sub article (1) hereof, take all appropriate measures to examine, take delivery of, and register the cultural heritage so discovered.
3. Where the Authority fails to take appropriate measures within six months in accordance with sub-article (2) of this Article, the person who has discovered the Cultural Heritage may be released from his responsibility by submitting, a written notification with a full description of the situation, to the Regional government official.
4. The Authority shall ensure that the appropriate reward is granted to the person who has handed over a cultural heritage discovered fortuitously in accordance with sub-articles (1) and (2) of this Article. And such person shall be entitled to reimbursement of expenses, if any, incurred in the course of discharging his duties under this Article.

3.4 Government Administrative Structure

3.4.1.1 General

The Federal Democratic Republic of Ethiopia is administered through a hierarchical system as follows:

- Regions (National Regional States)
- Zones (within Regions)
- Woredas (similar to districts)
- Kebeles (similar to parishes)

[41] An updated Cultural Policy was published by the Ministry of Youth, Sports and Culture in 2003.

The powers of regional governments include establishment of a State administration that advances self-government and democratic order, protection of the Federal Constitution, enactment of the State constitutions and subordinate laws; formulation and execution of economic, social and development policies, strategies and plans of the State; administration of land and other natural resources in accordance with Federal laws and establishment and administration of the state police force; maintaining public order and peace within the State. The Federal Government and the States have concurrent power on matters of taxation. Accordingly, they jointly levy and collect profit, sales, excise and personal income taxes on enterprises they jointly establish. They also jointly levy and collect taxes on the profits of companies, on dividends due to shareholders, on incomes derived from large-scale mining and all petroleum and gas operations, and royalties on such operations (GoE 2006).

As stated in the MPIDP FS, at the regional level, the Bureau of Water Resources Development is mandated to, among other things, supervise the balanced distribution and utilization of the region's water resources for various types of service, grant permits to and supervise waterworks engaged in the construction of dams and other works for the use of the water resources of the region, and collect charges for water use. Other relevant offices include the agriculture and rural development, health, investment, and tourism and culture offices, and Lake Tana marine transport office.

3.4.1.2 Woreda Administrations

As stated in the MPIDP FS, the woreda administration is a major decision-making government organ. The woreda administration has the following duties and responsibilities, among others:

- Implementation of the policies, laws and directives of the state.
- Coordination of the activities of various offices in the woreda.
- Maintenance of peace and security in the woreda, directing the police and security forces.
- Planning and implementation of projects.
- Supervision of development programs within the woreda.
- Proper use and accounting for the annual budget.

At the district level, the woredas are the key focus of the government's commitment to decentralized delivery of services. The various departments at woreda level have specialists who advise development agents (DAs) working at the village level. They are called upon to provide inputs and management controls relating to soil and water conservation, small-scale irrigation development, rainwater harvesting, road development, water supply, sanitation and waste management associated with rehabilitated schools and clinics. The project area falls exclusively in Dembia woreda of the North Gonder Zone in ANRS.

3.4.1.3 Kebele Administrations

As stated in the MPIDP FS, the kebele is the lowest administrative level structure. It generally comprises sub-kebeles and is headed by an elected chairman. Based on the Consultant's assessment, eight kebeles of Dembia woreda will benefit from the project. These kebele areas fall partially or fully within the project area. The main responsibilities of the kebele administration include preparation of an annual kebele development plan; ensuring the collection of land and agricultural income tax; organizing local labour and in-kind contributions for development activities; and resolving conflicts within the community through the social courts.

3.5 International Aspects

3.5.1 International Environmental and Social Agreements

Ethiopia has ratified the following international conventions on natural resources and environmental management:

- Convention on International Trade in Endangered Species (CITES) (ratified through Proclamation No. 14/1970).
- Framework Convention on Climate Change (ratified through Proclamation No. 97/1994).
- Convention on Biological Diversity (ratified through Proclamation No. 98/1994).
- The UN Convention to Combat Desertification (ratified through Proclamation No. 80/1997).
- The Cartagena Protocol on Bio-Safety to the Convention on Biological Diversity (ratified through Proclamation No. 362/2003).

- Convention Concerning the Protection of the World Cultural and Natural Heritage (World Heritage Convention): ratified 1977.
- Convention for the Safeguarding of the Intangible Cultural Heritage (UNESCO, 2003): ratified 2006.
- International Treaty on Plant Genetic Resources for Food and Agriculture.
- Convention on the Control of Transboundary Movements of Hazardous Wastes and their disposal (Basel Convention): ratified 2000.
- Stockholm Convention on Persistent Organic Pollutants (Stockholm Convention): ratified 2002.
- Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention): entered into force 01 Jan. 2010.
- African-Eurasian Waterbird Agreement: ratified February 2010.

Significantly, as yet Ethiopia has not signed the Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar Convention)

In the social arena, Ethiopia is a state party to the International Covenant on Civil and Political Rights, the African Charter on Human and Peoples' Rights, the Convention on the Rights of the Child, the Convention on Elimination of all Forms of Discrimination against Women, the ILO Worst Forms of Child Labour Convention, 1999 (No. 182) and 20 other ILO conventions, and the Geneva Conventions.

With respect to the River Nile and transboundary issues, in 2010 Ethiopia signed the Nile Cooperative Framework Agreement but this has not been signed by the Sudan or Egypt, the two downstream riparians.

3.5.2 Funding Agency Safeguard and Other Policies

3.5.2.1 World Bank Policies

The project's international financial sponsor is the World Bank. The Bank has a number of "safeguard policies" to ensure that the projects which it funds are environmentally and socially acceptable. The ToR for this study list seven safeguard policies (Operational Policies: OP) applicable to the three projects - MPIDP, Ribb IDP and Anger Dam - as shown in Table 3-2.

Table 3-2: WB Safeguard Policies Relevant to ENIDP

Policy and Reason for Application to MPIDP
OP 4.01 Environmental Assessment -- is triggered in view of the impacts of irrigation development on the environment. The feasibility studies for each scheme include environmental analysis to facilitate the development of proposals that avoid or minimize potential adverse environmental impacts. An independent ESIA will be needed for each scheme once their designs are reasonably advanced.
OP 4.04 Natural Habitats -- is triggered in view of the potential impact of irrigation development on natural habitats, especially around Lake Tana. Natural habitat concerns will be addressed during the feasibility studies and then in the ESIAs.
OP 4.09 Pest Management -- is triggered, as the project will actively promote increased use of inputs. The EMPs of each scheme will need to include an Integrated Pest Management Plan.
OP 4.11 Physical Cultural Resources – may be triggered. The ESIAs will include sufficient field work to determine if the policy should be triggered and detailed surveys carried out.
OP 4.12 Involuntary Resettlement -- is triggered since infrastructure works may entail the acquisition of land owned or used by individuals or families. Resettlement Action Plans are being separately prepared for each scheme.
OP 4.37 Safety of Dams -- is triggered since the Ribb and Anger schemes will rely on water storage facilities. MoWE is responsible for separately contracting dam safety advisers for the dams, and has already done so for Ribb.
OP 7.50 Projects on International Waterways -- is triggered as the investments may affect downstream water quantity or quality in the Nile Basin. Riparian notification is being handled through Nile Basin consultative processes by MoWR.

Source: ToR for this ESIA (see Annex 11 of this report)

The ENIDP's Environmental and Social Management Framework (ESMF: ERM 2007) includes one additional policy not listed in the ToR - Indigenous Peoples - as follows:

> "***OP 4.10 Indigenous Peoples*** *-- this OP may be triggered. The ESMF provides a procedure for determining whether indigenous peoples may be affected by the project, or could benefit from it; whether additional studies or planning will be needed and, if so, how they will be carried out.*"

As noted below, following assessment of the social situation, the ESIA study team does not consider that OP 4.10 is triggered.

Neither the ToR nor the ESMF comment on the applicability of the Bank's **OP 4.36 Forests**, although this would certainly apply to the Anger Dam scheme if its construction were to be funded by the Bank. OP 4.36 is not triggered by the Megech project due to the lack of natural forest vegetation in the project area, a landscape heavily used and heavily grazed for centuries (see description in Chapter 4).

One further important Bank policy applicable to the Megech project is the un-numbered **World Bank Policy on Disclosure of Information** (World Bank 2002). This requires that the borrower's EA report (in this case, the final ESIA report for MPIDP) is made publicly available after the draft report has been made available to project-affected groups and NGOs, and prior to formal project appraisal by the Bank.

These policies have many implications for assessment of the project. For example, OP 4.01 requires proposed projects to be screened into different categories based on their potential impacts; the Megech, Ribb and Anger projects all fall into Category A, the highest level, because of their location in sensitive environments and potential for major social and other impacts. The Bank requires that projects in Category A undergo a comprehensive environmental assessment (EA) by "independent EA experts not affiliated with the project", which is the reason that this study is being undertaken by companies not involved in the project's technical design.

The various OPs each have an associated Bank Procedure (BP), and in turn these are supported by a very large volume of guidance on requirements, methodology, and products. For example, OP 4.01 Environmental Assessment is supported by the Bank's multi-volume *Environmental Assessment Sourcebook* (1999) and its 28 *Updates*, together with numerous sectoral guidelines such as the 1996 *Participation Sourcebook*, the 1997 *Roads and the Environment Handbook*, and the 2003 *Social Analysis Sourcebook*. OP 4.09 Pest Management is supported by an extensive dedicated website hosted by the Bank. OP 4.11 Physical Cultural Resources is supported by the new (2009) *Physical Cultural Resources Safeguard Policy Guidebook* and Cultural Resources *Country Profiles*, including one for Ethiopia. OP 4.11 Involuntary Resettlement is the subject of a huge body of guidance and accumulated advice based on more than a generation of Bank-sponsored resettlement activities.

Typically each Policy requires that an appropriately detailed investigation of the proposed project's potential effects should be carried out, and any predicted significant negative impacts avoided or minimised by counter-measures ("mitigation measures"). The assessments should be carried out by qualified and experienced specialists, and involve a high level of consultation and participation by stakeholders. The products of these sectoral assessments are topic-specific plans, e.g. a Pest Management Plan, a Cultural Resources Management Plan, a Resettlement Action Plan, and so on, formulated as components of the project's overall Environmental and Social Management Plan.

The procedures and products mandated by the Bank's safeguard policies are similar to those required under Ethiopian legislation and guidelines, but in more depth and with a specific terminology.

3.5.2.2 Compliance with Funding Agency Requirements

In summary, the Bank's policies and their applicability to the MPIDP are listed in Table 3-3, together with the corresponding actions by the ESIA study team or by others, and the main products from the assessment process.

Table 3-3: WB Safeguard Policies Applicable to MPIDP & Study Response

Policy	Action	Main Product
OP 4.01 Environmental Assessment	Comprehensive independent EA (ESIA) by BRLi-MCE	EA report with EMP (in this case, an ESIA report with ESMP)
OP 4.04 Natural Habitats	Assessed within ESIA by BRLi-MCE	Analysis, mitigation and enhancement measures in ESIA and ESMP
OP 4.09 Pest Management	Assessed within ESIA by BRLI-MCE	Integrated Pest Management Plan (IPMP) as component of ESMP
OP 4.10 Indigenous Peoples	Not applicable - no indigenous people (see description of social setting in Chapter 4)	-
OP 4.11 Physical Cultural Resources	Assessed within ESIA by BRLi-MCE	Reconnaissance Physical Cultural Heritage Survey in ESIA as precursor to Physical Cultural Resources Management Plan (PCRMP)
OP 4.12 Involuntary Resettlement	Independent preparation of RAP by SMEC	Resettlement Action Plan (RAP)
OP 4.36 Forests	Not applicable - no forests (see description of environmental context in Chapter 4)	-
OP 4.37 Safety of Dams	Not applicable - no dam	-
OP 7.50 Projects on International Waterways	Handled through Nile Basin consultative processes by MoWE	-
Disclosure of Information	Responsibility of proponent (MoWE) and WB after completion and approval of ESIA	-

Source: Consultant

4. Project Setting

4.1 Introduction

This chapter describes the setting of the proposed project under the main headings of physical environment, biological environment, and social and economic context. The last section of the chapter gives a brief description of other similar projects under construction or planned for the Lake Tana basin.

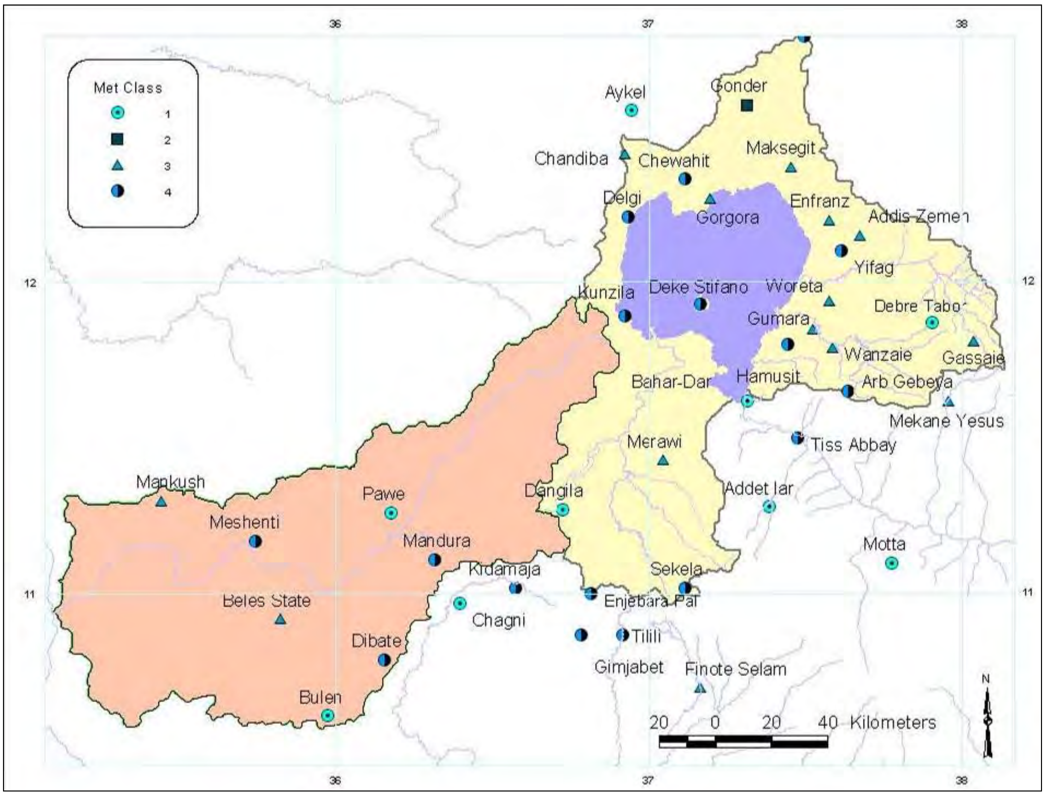
4.2 Physical Environment

4.2.1 Hydrology and Water Resources

4.2.1.1 Existing Hydrometric Network

Meteorology: there are some 46 meteorological stations in and around the Tana and Beles basins, ranging from simple rainfall stations (meteorological class 4), to rainfall and temperature stations (class 3) and rainfall, temperature, sunshine, radiation, humidity, wind speed stations (class 1). Their locations are shown in Figure 4-1 below. The closest station to the PCA is at Gorgora, a few km to the south.

Figure 4-1: Meteorological Stations in Tana-Beles Sub-Basins

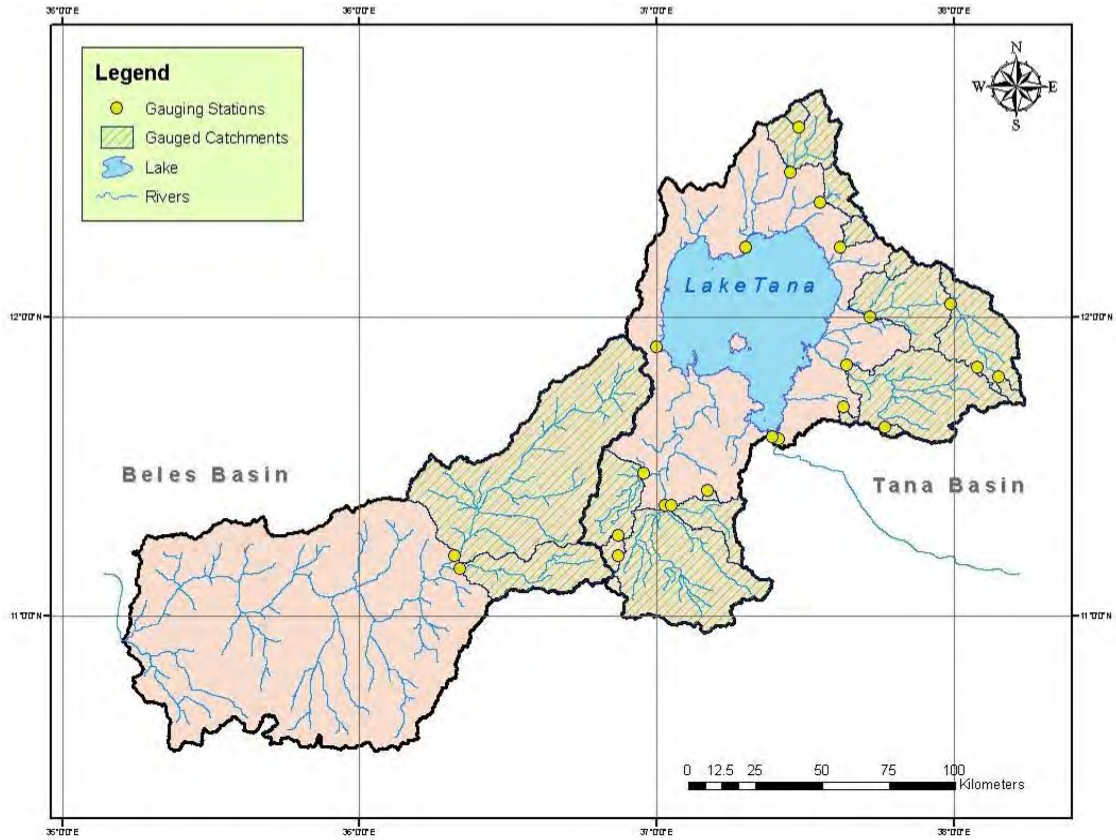


Sources: SMEC, 2008. Hydrological Study of the Tana-Beles Sub-Basins. Hydrological Monitoring Network

Surface water: measurements on the major rivers in the Tana and Beles basins (which are "sub-basins" of the Abbay or Blue Nile) started around 1959, during the Abbay Basin Study carried out by USBR (1964). There are presently about 28 hydrometric stations in the Tana-Beles area and three lake level monitoring stations. Some have a long record, others have only been in operation for a short time. Station locations are shown in Figure 4-2.

The catchment area of the Lake Tana basin is reported to be around 115,000 km^2. Within the basin about 42% of the catchment area is gauged, but only 36% of the area is gauged by primary stations with a reasonable length of record. The major rivers with gauges are the Gilgel Abay near Merawi, Koga near Merawi, Gumera near Bahir Dar, Ribb near Addis Zemen, and Megech near Azezo. In the Beles basin some 29% of the area is gauged.

Figure 4-2: Hydrometric Gauging Stations and Gauged Catchments in the Tana Beles Sub-basins



Sources: SMEC, 2008. Hydrological Study of the Tana-Beles Sub-Basins. Hydrological Monitoring Network.

Groundwater: currently there is no groundwater monitoring network in the Tana-Beles sub-basins.

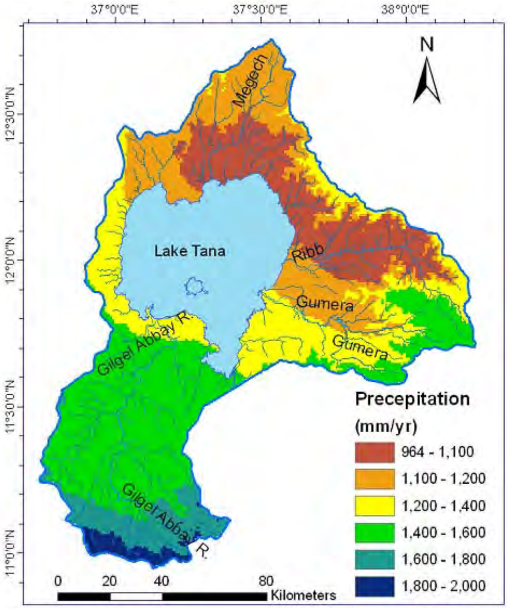
Quality analysis of the monitoring system: many problems with the system were identified by the SMEC (2008) hydrological study, including non-adapted site locations, siltation, bank overflow, unstable cross-sections and missing data. In view of the problems related to gaps in the data records, non-homogeneities, inconsistencies, wrong entries in the databases, heavily extrapolated rating curves, etc., the data quality was considered moderate to moderately poor. Consequently for the SMEC study many corrections and correlations had to be made to elaborate the water allocation model (see Chapter 6 for a brief description of the model): time series of rainfall and runoff data were prepared for sub-catchments which correspond to (i) catchments upstream of hydrometric stations, and (ii) catchments up- and downstream of major existing or potential hydraulic structures, such as diversion weirs and dams. The time series upstream of hydrometric stations were primarily used for calibration of rainfall-runoff models. Rainfall time series for catchments up- and downstream of major hydraulic structures were used in the preparation of runoff time series for river basin simulation.

4.2.1.2 Rainfall

The western and north-western parts of Ethiopia have two seasons, namely the main rainy season (*kerem't*) which runs from June to September, and dry season. The climate of the study area is largely controlled by the movement of the inter-tropical convergence zone, which results in a single rainy season between June and September. Unlike areas further east, there is no short rainy season (*belg*). The main rainy season runs from June to September (around 80% of the annual rainfall), with a peak in July or August.

Mean annual rainfall over the Lake Tana basin is estimated to be 1,326 mm, with slightly more rain falling in the south and south-east than in the north of the catchment (Figure 4-3). The highest rainfall occurs over the Gilgel Abbay catchment in the south (~ 1,600 mm). By comparison, the mean annual precipitation of the Gumera, Ribb and Megech watersheds is lower (~ 1,100 mm).

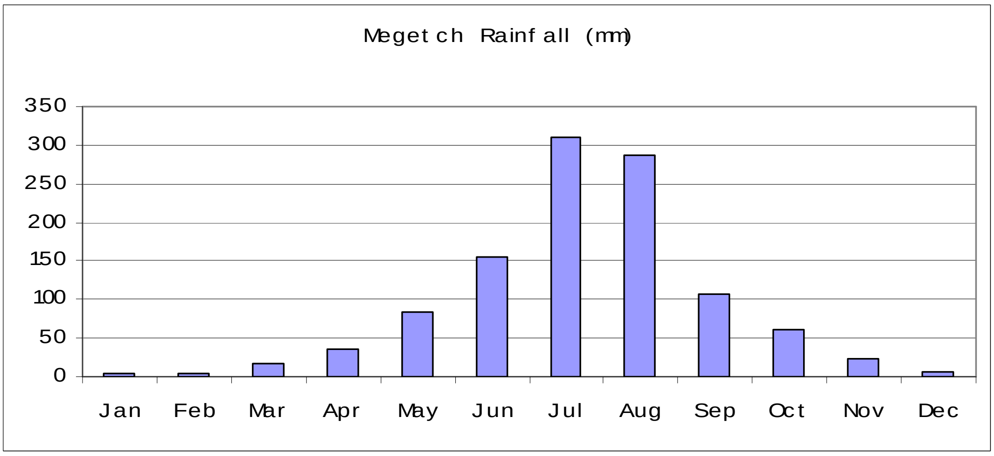
Figure 4-3: Annual Rainfall in Lake Tana Basin



Source: Yilma & Awulachew (2009)

Rainfall in the project area is uni- or mono-modal, peaking in July and August (Figure 4-4). Nearly 80% of total rain occurs in the period of June-September (main rainy season).

Figure 4-4: Monthly Rainfall - Gorgora



Source: Megech Dam FS - Hydrology (TAHAL-CECE 2008)

Rainfall intensity at Gonder is given in Table 4-1.

Table 4-1: Rainfall Intensity for Different Return Periods, Gonder

Return Period (Years)	Rainfall Amount (mm/24 hours)
5	64
10	72
25	81
50	88
100	94

Source: MPIDP FS (TAHAL-CECE 2010)

4.2.1.3 Other Climatic Parameters

The following information is taken from the MPIDP FS:

- Average daily temperatures vary little throughout the year (19°C in December to 23°C in May). Maximum temperatures over the year vary within a range of ±5°C, and within a range of ±4°C for minimum temperatures.
- Relative humidity varies from 77% in February to 88% in August.
- Wind speeds are low, thus minimising potential evapotranspiration values from as low as 95 mm/month in December to as high as 141 mm/month in April. Average annual evaporation over the lake surface is approximately 1,675 mm (SMEC, 2008).
- Sunshine duration is reduced to 6-6.5 hours during July and August due to cloud cover.

4.2.1.4 Climate Change

The impacts of climate change on the Lake Tana basin and Upper Blue Nile have been examined recently by Elshamy *et al.* (2008) who examined 17 general circulation models (GCMs). As reported in McCartney *et al.* (2010), the GCMs indicated precipitation changes between +14% and -15%, translating into changes in annual flow of the Blue Nile at the border with Sudan of +45% to -60%.

Kim *et al.* (2008) also compared multiple GCMs. The outcomes were used to modify a baseline climate scenario representing current precipitation and temperature patterns. This was linked to hydrologic models. The results suggested that (i) the climate in most of the Upper Blue Nile River Basin is likely to become wetter and warmer in the 2050s (2040-2069); (ii) low flows may become higher and severe mid- to long-term droughts are likely to become less frequent throughout the entire basin. In contrast Shaka's analysis (2008) found a decline in runoff into Lake Tana.

McCartney *et al.*'s (2010) conclusion is that climate change means that stationarity (flow fluctuation within predictable, unchanging limits) can no longer be assumed, and all future water resources development must be designed so as to be able to adapt to changed conditions.

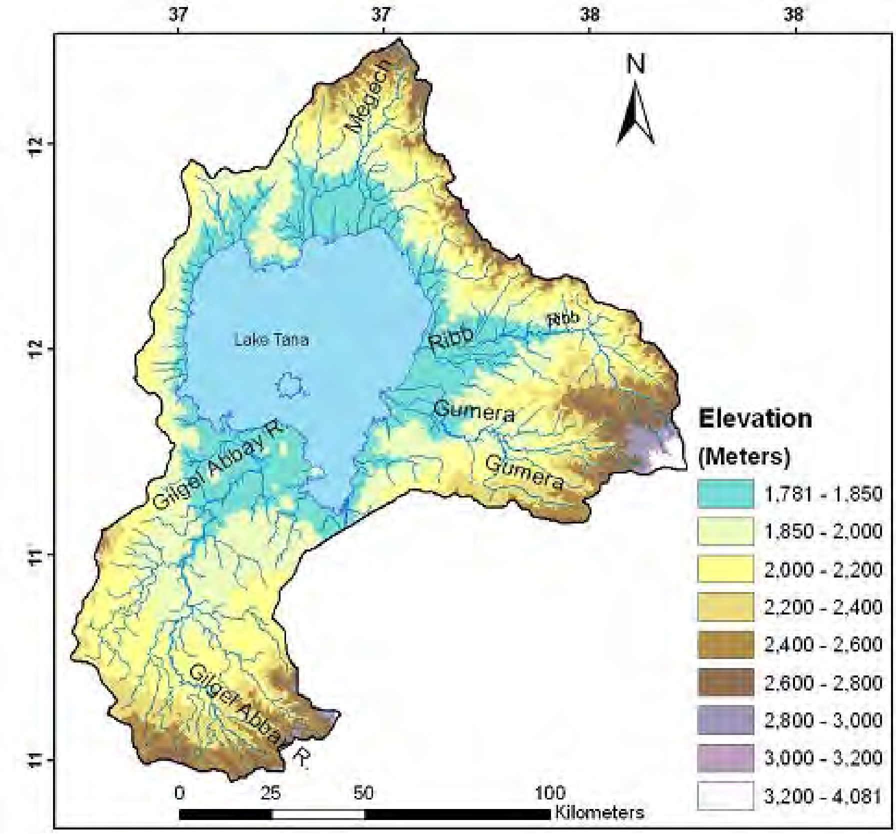
4.2.1.5 Agroecozone

The study area falls within the temperate, cool sub-humid highlands agroecozone (*Weina Dega*): areas between 1,500 and 2,500 m where annual rainfall ranges from 800-1200 mm. This is zone where most of the Ethiopian population lives and where many types of crop can be grown, especially teff.

4.2.1.6 Surface Water

Lake Tana is a large (3,059 km^2), very shallow (max. depth 15 m) lake fed by four major rivers - Gilgel Abbay (Little Nile), Gumera, Ribb and Megech (Figure 4-5).

Figure 4-5: Lake Tana area - Regional Hydrology and Topography



Source: Yilma & Awulachew (2009)

The major catchments within the Lake Tana basin have different responses to rainfall caused by varying topography, soils, vegetation cover and land use. Runoff observed in the Gilgel Abay near Merawi is very high whereas the neighbouring Koga catchment has a much lower runoff. The adjacent Gumara and Ribb catchments show entirely different runoff patterns (Table 4-2 and Figure 4-6).

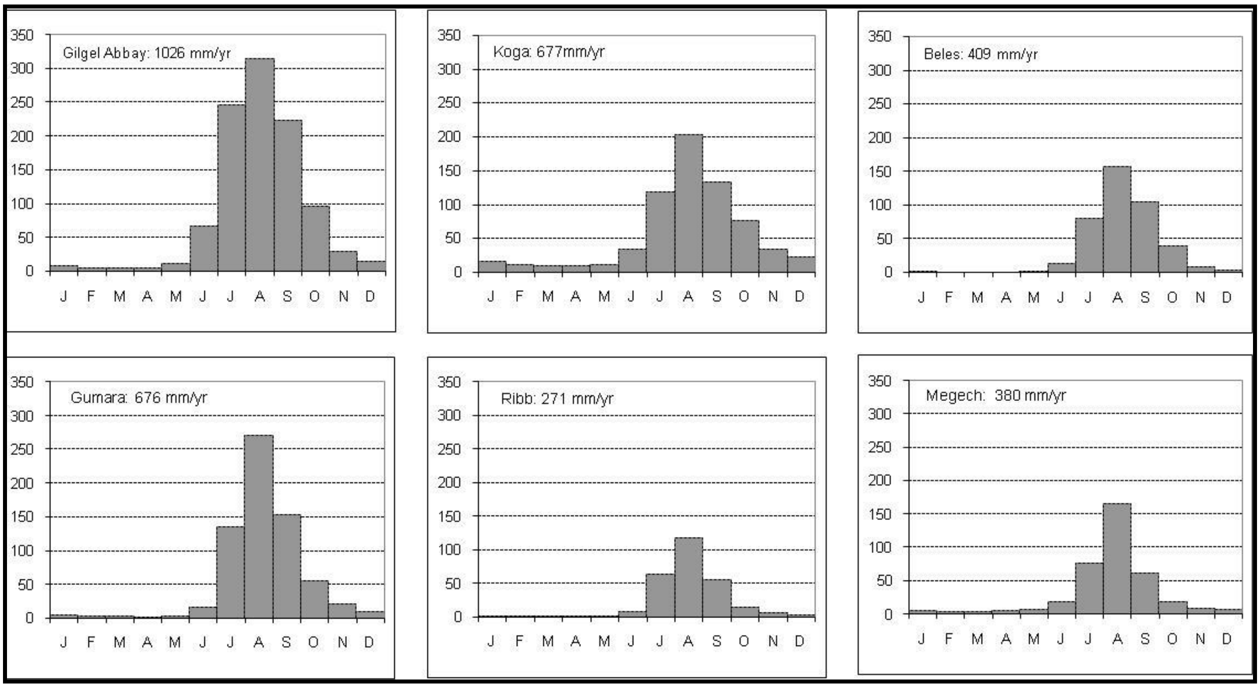
Table 4-2: Annual Rainfall and Runoff of Gauged Catchments around Lake Tana

Catchment	Area (km^2)	Rainfall (mm/year)	Runoff (mm)
Gilgel Abay nr. Merawi	1,664	1,759	1,088
Koga nr. Merawi	244	1,562	650
Gumera nr. Bahir Dar	1,394	1,328	673
Ribb nr. Addis Zemen	1,592	1,245	270
Megech at Azezo	462	1,050	409

Source: Tana-Beles Hydrology Report (SMEC, 2008). [42]

[42] Available hydrological data feature a number of problems including gaps in records, non-homogeneity, inconsistency, incorrect entries in databases, and heavily extrapolated rating curves. The rating curves of Megech and Ribb Rivers are known to have serious problems and the flow data should be used with caution.

Figure 4-6: Monthly Runoff for Gauging Stations around Lake Tana



Source: Tana-Beles Hydrology Report (SMEC, 2008).

4.2.1.7 Floods

The project is situated in the Dembia Plain, a floodplain bordering Lake Tana. Flooding is a major feature of life in the command area and has significant implications for all aspects of project design and implementation. Basic statistics on flood effects in Dembia Woreda are given in Table 4-3.

Table 4-3: Flood Impact Statistics, Dembia Woreda

	2006-7	2007-8
Affected kebeles	8	9
Affected households	5,871	8,151
Total affected population	29,275	43,275
Affected agricultural land (ha)	4,208	6,732

Source: Dembia WoARD, in Halcrow-GIRD (2010)

Flooding in the Dembia Plain has been investigated twice in recent years, by SMEC (2006), and Riverside (2010). Flooding mostly occurs in the lower part of the Dirma, Megech and Shenzeli Rivers (Figure 4-7).

Floods in the command area are caused by a combination of factors, principally:

- **Runoff from upper watersheds:** the MPIDP FS identifies 47 catchments or sub-catchments contributing to floods or runoff within the PCA, with catchments varying in size from 0.1 km^2 to 349 km^2 according to interpretation of the 1:50,000 topographic maps. In the absence of any gauging data, flood flows were estimated for these catchments using the US SCS unit hydrograph method which relies on Curve Numbers (CN), in turn relying on soil and land use maps. The basic rainfall data applied was the Gonder 24-hour rainfall frequency analysis using a log-Pearson distribution. This method generated design flows for all streams crossing into the command area for 5, 10, 25, 50 and 100 year events. Flows range from 0.13 m^3/s for the smallest catchment with a 5-year event, to 329 m^3/s for the largest catchment (Dirma River) for a 100-year event.

  In addition to contributing large volumes of water to the command area during heavy rains, these watercourses bring large quantities of sediment eroded from their catchments.

Figure 4-7: Catchments causing Flooding on Dembia Plain

Source: Tana-Beles Hydrology Report (SMEC, 2008).

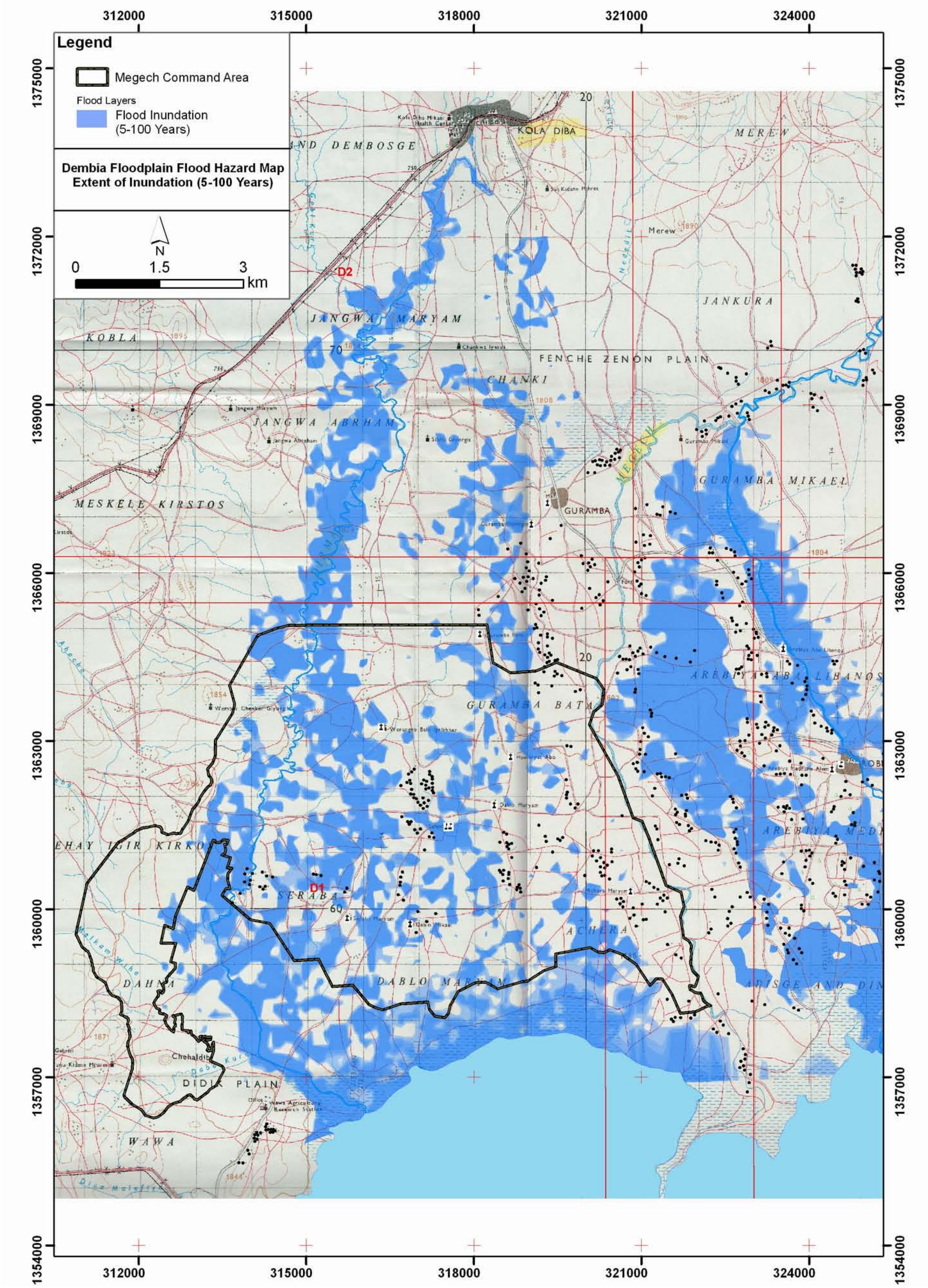
- **Direct rainfall over the command area:** direct rainfall makes a major contribution to flooding since although intensities are relatively low (Table 4-1), rain may be persistent and frequent, falling onto fully-wetted ground and therefore unable to infiltrate. In addition, the main natural drainage channels tend to silt up due to the high sediment levels of waters from the contributing catchments upstream; this both raises bed levels and, when overbank flow occurs, creates natural levees (raised areas along river banks). Drainage channels and watercourses may also be obstructed by informal diversions for small-scale irrigation.
- **Fluctuations in level of Lake Tana:** historically, lake levels have fluctuated within the range of 1,784.26 m to 1,787.81 m. As lake levels rise each rainy season, flows into the lake are impeded. A backwater effect reaching some 3 km from the lakeshore is reported in the MPIDP FS.

Flood Hazard and Risk Maps: flood hazard maps of the area have been developed by Riverside (2010) showing flood depths and extent for various return periods (2, 5, 10, 50 and 100 years) (Maps 3.1 - 3.5 in Annex 1). Importantly, the maps show that overbank floods from the Megech River in its new channel do not affect the command area (Figure 4-8).

4.2.1.8 Groundwater/Hydrogeology

As stated in the MPIDP FS, the two major aquifers in the Megech River basin are the Quaternary sediments aquifer and the underlying Tertiary basalt aquifer. The Quaternary aquifer is predominant in the Dembia Plain, including the project area. It hosts shallow fresh groundwater and lenses of brackish to saline groundwater, which occurs in some localities (Seraba, Adisge Dinge and Achera) at the lower reach of Megech River. The Quaternary sediments consist of a number of thin sandy aquifers separated by clayey aquitards. Average thickness of this unit is about 80 m, but locally it can be thicker or absent.

Figure 4-8: Extent of Flooding from Dirma and Megech Rivers



Source: Final Report on Flood Risk Mapping Consultancy for Pilot Areas in Ethiopia (Riverside, 2010)

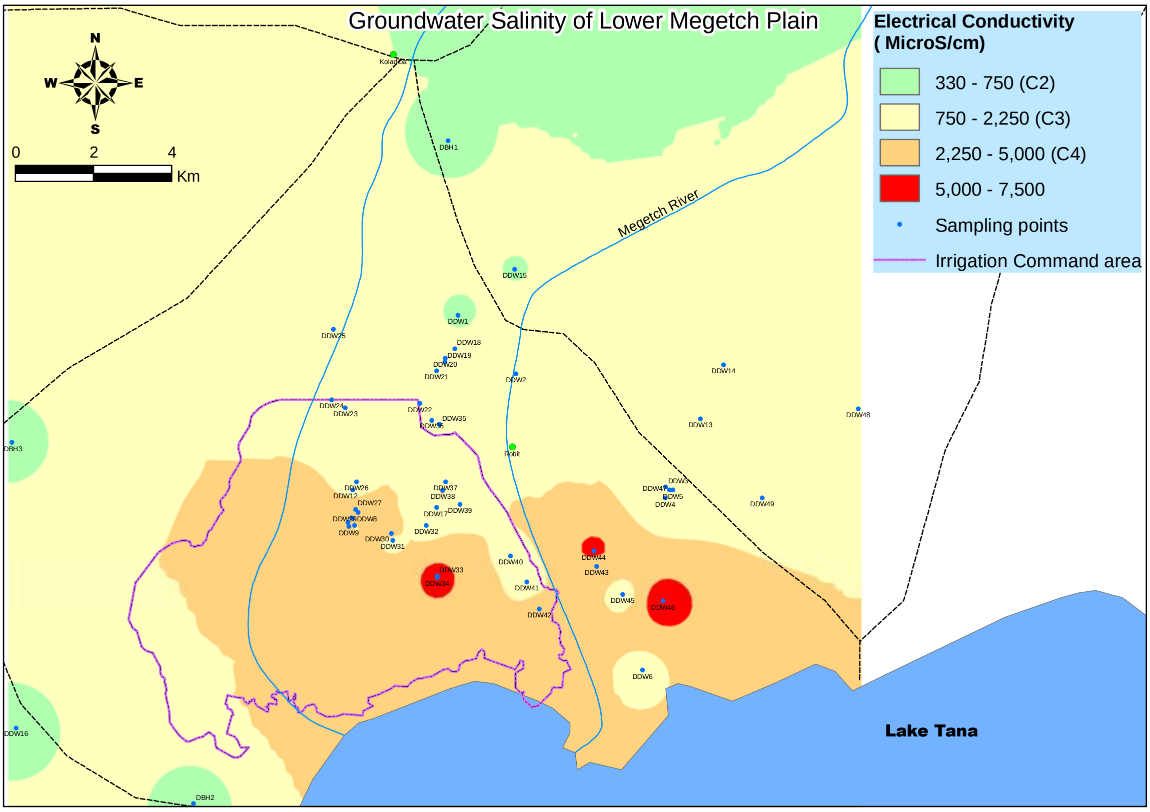
Recharge, as estimated by base flow separation, is 105 mm, which is some 10% of the annual rainfall. Groundwater levels generally become shallower towards the lake shore. Seasonal ponds occur near the shore following the main rainy season (June-September). The depth below ground surface at which groundwater evaporation is considered negligible is 8 m.

The groundwater elevation contour map suggests that the major direction of shallow groundwater flow is towards Lake Tana. The water table, in the Megech plain and near the lakeshore, is very shallow (2 - 7 m). The hydraulic gradient is extremely shallow in the plain, and the lake level rises in the wet season creating a nearly flat gradient leading to sluggish groundwater flow and waterlogging.

4.2.1.9 Water Quality

Groundwater: as stated in the MPIDP FS, groundwater in the PCA is generally fresh and relatively hard. However, shallow groundwater, less than 3 m, is subject to direct evaporation and salinity buildup. Much of the groundwater in the Megech plain belongs to the C3 salinity class (High Salinity, cannot be used in areas of restricted drainage) (Figure 4-9). Due to evaporation of the shallow groundwater, highly saline localised groundwater occurs at some localities, such as in Seraba Dabelo kebele (at Weynit) and at Robit. The salinity level, in places, is much higher (5,000-8,000 µS/cm) than the maximum recommended limit for irrigation (Class 4, Very High Salinity, = 5,000 µS/cm). Saline soil associated with saline groundwater may exist as well.

Figure 4-9: Groundwater Quality in PCA



Source: MPIDP FS

Considerable salinity variations are observed in juxtaposed locations. For instance, at Weynit, EC increases from 2,200 to 4,700 µS/cm within about a 20 m distance between two dug wells. At several other locations, EC changes by a factor of 1.3–2.5 within less than 100 m.

In general, the brackish groundwater moves between zero and 6 m below ground surface in the Megech plain. If the water level permanently rises to higher level, the saline water will be transported to surface and will threaten soil and root zone water quality. Care should be taken not to induce high water level rise as a result of irrigation.

Overall, it appears that groundwater quality and quantity are not adequate for large-scale irrigation (MPIDP FS).

Surface water: the MPIDP FS reports that the agricultural water quality of the three surface water bodies – Lake Tana, Ribb River and Megech River – has been assessed based on quality criteria, particularly salinity, expressed in terms of electrical conductivity. Except hardness, all parameters in the three water samples are within acceptable limits. The pH of the three water samples is near the upper boundary of the recommended limit, as the FAO standard for pH in irrigation water is between 6 and 8.5. Considering EC and other parameters, Lake Tana, the Ribb River and the Megech River have been ranked first, second and third, respectively, in terms of their fitness for irrigation uses.

Water quality data for Lake Tana, the Megech River and various sources of drinking water in the Megech area are given in Annex 4.

4.2.2 Geology, Soils and Topography

4.2.2.1 Geomorphology

As described by Birru (2007), the two main geologic and geomorphologic formations in the Lake Tana basin are the Pleistocene to recent alluvial deposits adjacent to the lake and the underlying Tertiary volcanics (predominantly basalt and tuffs) forming the surrounding hills. The alluvial deposits, which form extensive plains on south, east and north sides of the lake, are comprised predominantly of lacustrine and fluvo-lacustrine sediments, the latter formations generated by streams reworking former lake deposits and the deposition of new materials eroded from the higher ground. Resistant basalts are responsible for the high to mountainous relief of the upper catchment of the Ribb and Gumera Rivers in the eastern part of the basin. Low relief hills and low plateaux, formed from successive stratiform lava flows, are located adjacent to the plains. A transitional footslope zone, often with shallow alluvium and colluvium overlaying the main basalt formation, connects the plains with the surrounding hills.

The project command area is a nearly level plain approximately 11 km from east to west and 8 km from north to south (Photo 4-1). The slope ranges from 1 to 2% and the elevation from 1,785 m a.s.l at the edge of the lake to 1,820 m a.s.l. Throughout the plain there are numerous gentle depressions which are seasonally flooded, typically during July and August. Drainage is generally complete by October, although some permanent ponds and marshy areas remain.

Surrounding the area are low hills, some rocky, some more gentle, formed from volcanic rocks and drained by numerous tributaries of the Dirma River. When these streams reach the floodplain their character changes from erosional (Photo 4-2) to depositional. The major rivers have a tendency to change course from time to time, as happened with the Megech River when it abandoned its old course to move further east some nine years ago.

Photo 4-1: Project Command Area from south near Gorgora

Photo 4-2: Active erosion along Dirma tributary adjacent to Dembia Plain

4.2.2.2 Soils

A semi-detailed soil survey by the design consultant (one auger boring every approx. 9 ha) identified three major soil types in the command area, namely Eutric Vertisols, Eutric Fluvisols and Eutric Gleysols, in order of their extent. The vertisols occupy almost all the project area, the fluvisols occur in a strip along the Megech River, and the small area of gleysols lies along the shore of Lake Tana (Figure 4-10).

The vertisols, commonly known as black cotton soils and locally termed *walka*, are dominantly clayey and generally poorly drained with relatively slow infiltration and permeability. When dry they crack deeply (Photo 4-3), but when wet they swell and become essentially impermeable. They have a very limited range of moisture conditions when cultivation is possible using traditional implements, are highly erodible, and are very slippery when wet making use by wheeled traffic essentially impossible during the rainy season.

Photo 4-3: Typical vertisols in command area, January 2009: note deep cracking

The fluvisols (*dashena*) are coarse textured and generally well drained. The gleysols are fine-textured (silts and clays), saturated and partly or wholely anaerobic.

The pH of the vertisols is slightly acidic to neutral in the surface horizons and alkaline in the subsurface horizons, with some carbonates. The electrical conductivity (EC) of the dominant vertisols is generally low in the upper 1 m but between 1 m and 3 m depth increases to >2 dS/m, before decreasing again at greater depths.

Soil salinity correlates well with groundwater salinity. Exceptionally high EC values (4 to 20 dS/m) were measured in six soil profiles, associated with high groundwater.

As stated in the FS, in terms of suitability for irrigation, slow drainage – associated with heavy clay texture, flat topography and shallow groundwater table – and flooding are the major limitations restricting irrigation suitability and land capability (Photo 4-4). Using the FAO guidelines for land evaluation for irrigated agriculture, some 4,313 ha of the overall soil survey area of about 6,000 ha is not suitable for irrigation due to poor drainage (N1 in Figure 4-10). If drained, a total of 4,732 ha of land is potentially suitable for irrigation.

Improvement of drainage and flood control, and selection of suitable land use, are required for improvement of agricultural productivity in the area. Monitoring and control of salinity and sodicity hazards, as well as the effects of a calcium (Ca) fertilization trial, are recommended in the FS.

The hills surrounding the command area are generally covered by well drained brown soils (Chromic Cambisols).

Photo 4-4: High water table, command area, Dec. 2009

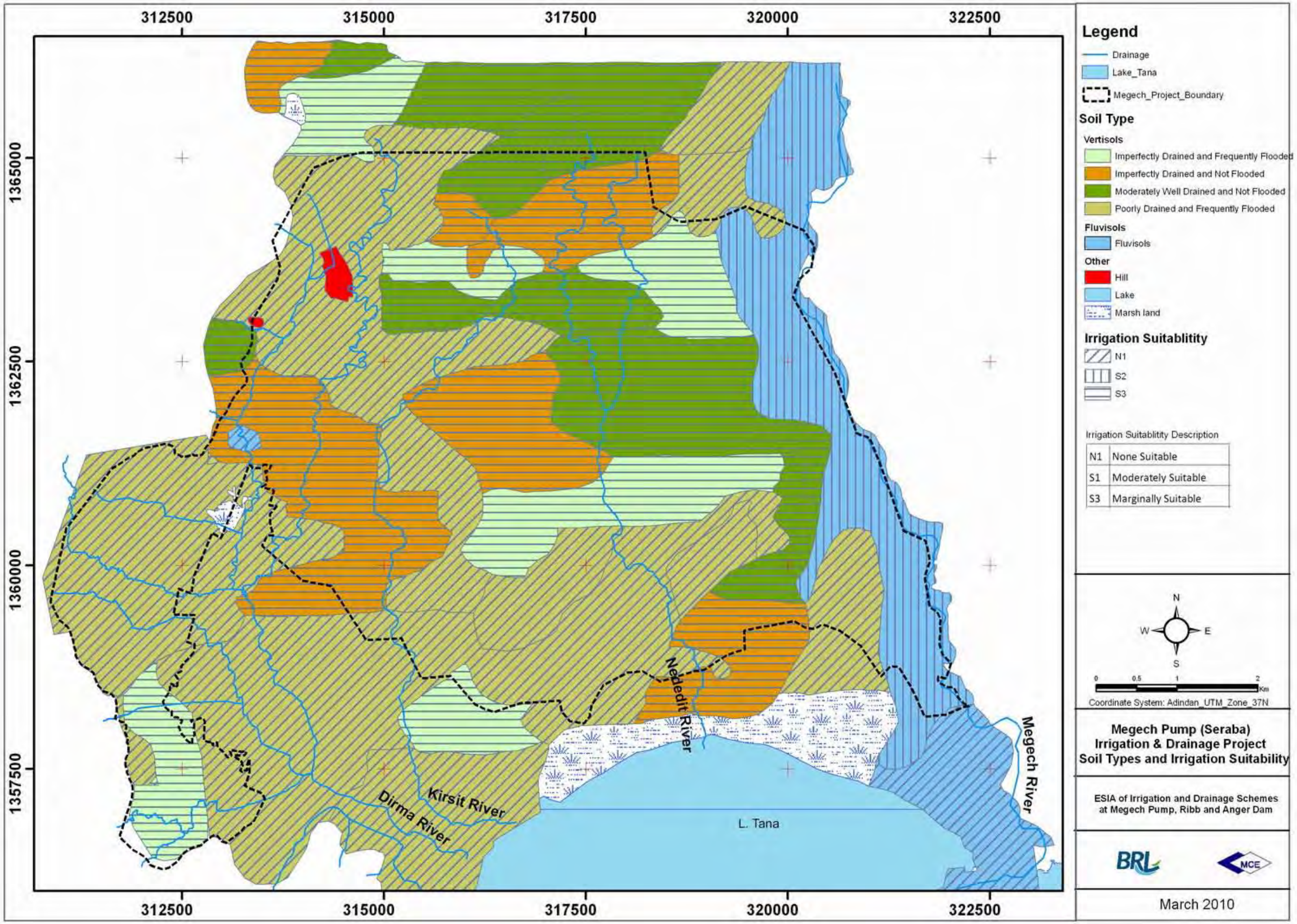
4.2.2.3 Seismology

Historical records over the last 600 years and recent instrumental observations show that earthquakes in Ethiopia mainly occur in the Afar Depression, the escarpments, and the main Ethiopian rift (National Atlas of Ethiopia: Ethiopian Mapping Authority 1988). The standard reference work on Ethiopian earthquakes is Gouin (1976).

Earthquakes occur from time to time in the Lake Tana area. Structures in Gonder were severely damaged by a quake in the early 19th Century. A list of earthquakes in the region is given in Ambraseys *et al.* (1994).

A seismic hazard assessment of the project was carried out as part of the project's engineering feasibility study (MPIDP FS, Annex C.2-3, Geotechnical Report). This found that the project area lies entirely in Seismic Hazard Zone 1, which is a zone of minor damage due to associated earthquake activity corresponding to intensities V and VI on the Mercalli Modified (MM) intensity scale. This zone is considered a no-risk zone in terms of damaging earthquakes.

Figure 4-10: PCA - Soil Types and Irrigation Suitability



4.3 BIOLOGICAL ENVIRONMENT

4.3.1 Overview

4.3.1.1 Ethiopian Biodiversity

Ethiopia's biodiversity is summarised in the National Biodiversity Strategy and Action Plan (IBC 2005). The country has enormous habitat diversity due to its highly variable topography, wide range of elevations and climatic diversity. This, together with its location in the Horn of Africa near the junction of the Afrotropical and Palaearctic biogeographical realms[43], has resulted in an exceptional range of plant and animal species, many of which are endemic (not found elsewhere) (Table 4-4).

Table 4-4: Biological Diversity in Ethiopia

Category	Number of known species in Ethiopia	Species endemic to Ethiopia
Higher plants	6,500-7,000	10-12 %
Mammals	277	31
Birds	926	29 (19 globally threatened)
Reptiles	210	9
Amphibians	71	24
Fish	162*	39

* Includes 10 exotic species

Note: different sources give different numbers of species and endemics; this table is not definitive

Sources: adapted from EWNHS (1996), IBC (2005) & Eshete Dejen (2008)

Ethiopia, together with Eritrea and part of Somalia have been recognised as one of the eight Vavilov Centres of Diversity[44], providing the world with numerous domesticated plants including, for example, Abyssinian hard wheat, poulard wheat, emmer, Polish wheat, barley, grain sorghum, pearl millet, African millet, cowpea, flax, teff, sesame, castor bean, garden cress, coffee, okra, myrrh and indigo. This recognition continues today, as noted in Davis *et al.* (2004). There are 428 endemic and near endemic woody taxa in Ethiopia and Eritrea, of which 107 are trees and 321 are shrubs (Vivero *et al.* 2004).

As with plants, Ethiopia provides habitats for a wide variety of wildlife: at least 926 bird species have been recorded, of which 17% are endemic, and so far 69 locations have been identified as Important Bird Areas (IBA) in Ethiopia (EWNHS 1996; EWNHS 2001); amongst these are some 30 wetlands which are also important for a large number of other taxa (Nega Tassie 2007). The Ethiopian Highlands Freshwater Ecoregion of Montane freshwaters is defined by the two blocks of highlands in Ethiopia, separated by the Rift Valley and distinguished by a freshwater fauna adapted to the region's swift-flowing waters (FEOW 2009a). Some 162 fish species[45] have been identified of which about 25% (39 species) are endemic. The endemicity is also expressed in other faunal groups such as Gastropods and Copepods.

Centuries of settlement, wars, and more recently a burgeoning population have resulted in major degradation and conversion of habitat. Consequently a number habitat types and wildlife species are under threat, especially wetlands and forests, and including 32 bird species which are globally threatened (of these no fewer than 10 are Palaearctic migrants, and 4 are Endangered[46] endemics). Globally threatened mammals in Ethiopia include Grevy’s Zebra (*Equus grevyi*), African Wild Ass (*Equus africanus*), Walia Ibex (*Capra walle*), Swayne's Hartebeest (*Alcelaphus buselaphus swaynei*), Tora

[43] Or "terrestrial ecozones": see description at http://en.wikipedia.org/wiki/Ecozone .

[44] Vavilov Centre of Diversity: a region of the world first identified by Dr. Kikolai Vavilov to be an original centre for the domestication of plants, and rich in the wild relatives of these plants.

[45] "At least" because new species continue to be found as scientific surveys extend to the many under-researched rivers; see, e.g. Eshete Dejen (2008).

[46] Endangered: as categorised in the IUCN Red List of Threatened Species: the main categories are Critically Endangered, Endangered, Vulnerable, and Near Threatened. See http://www.iucnredlist.org/

Hartebeest (*Alcelaphus buselaphus tora*), Speke's Gazelle (*Gazella spekei*), Mountain Nyala (*Tragelaphus buxtoni*), Dibatag or Clarke's Gazelle (*Ammodorcas clarkei*) and Ethiopian Wolf (*Canis simensis*) (IBC 2005). The Eastern Black Rhinoceros (*Diceros bicornis michaeli*) formerly found in Ethiopia has now been reduced to a tiny remnant population in Kenya.

A few species of plants and animals have been protected by legislation - for example, four trees have been protected under the 1994 Proclamation on Forestry Conservation, Development and Utilisation: *Hagenia abyssinica, Cordia Africana, Podocarpus gracilior* and *Juniperus procera* - and protected areas have been established in five categories (i) National Parks; (ii) Wildlife Sanctuaries; (iii) Wildlife Reserves; (iv) Controlled Hunting Areas, and (v) National Forest Priority Areas. The first four categories cover some 187,000 km^2 or about 16.5% of the country (IBC 2005), but only the Awash and Simien Mountains National Parks have been formally gazetted (EWNHS 2001). Few animals have received formal legal protection.

4.3.1.2 Lake Tana Area

Lake Tana is situated in the basaltic highlands of north-west Ethiopia at an elevation of 1785 m asl. Although the lake was originally formed by volcanic activity some 5 million years ago (Mohr 1962), recent geophysical and coring investigations indicate that the lake dried out completely as recently as 16,700 to 18,700 years BP (Lamb *et al.* 2004, 2007).

The Lake Tana area has a long history of human occupation and use and the natural landscape of the area has been substantially altered. The main drivers of change have been the need for firewood (deforestation), livestock husbandry (very high grazing pressure) and cultivation. As a result the ecological values of the area centre on the seasonal and permanent wetlands around the lake and the rivers which feed into it. In terms of terrestrial ecology, these values are mainly as habitat for both resident and migratory birds, and in terms of aquatic ecology, mainly as habitat for scientifically unique and commercially valuable fishes.

Surveys by the EWNHS have identified two IBAs in the 16,500 km^2 Lake Tana sub-basin (EWNHS 2001). These are, respectively, the Fogera Plains (IBA ET006) to the east of Lake Tana, crossed by the Ribb River, and Bahir Dar-Lake Tana (IBA ET007), comprising the whole of the lake together with its 37 islands but with a focus on the Bahir Dar area[47]. These sites are particularly important for waterbirds, many of which are migratory and some of which are globally threatened. In addition, as further surveys are carried out, additional areas around the lake are being identified as vital breeding habitat for some endangered birds (see Section 4.3.3 for further details).

With respect to fish, the lake is separated from the remainder of the Abbay (Blue Nile) river system by the 40 m high Tis Issat Falls near Bahir Dar. As a result there has been a dramatic speciation of the few species present when the lake began to form again some 15,000 years ago, so that 20 of the 27 fish species in the lake are endemic to it and the surrounding catchment (Vijverberg *et al.* 2009). 16 of these fish are *Labeobarbus* species, of which 15 are endemic[48]. These 15 large labeobarb species form a globally unique concentration of endemic cyprinid fish (Nagelkerke & Sibbing 2000)[49]. Seven *Labeobarbus* species are known to spawn in the upper reaches and tributaries of the larger rivers flowing into the lake (see Section 4.3.4 for further details).

In consequence of this diversity of habitats and species, Lake Tana has been categorised as **Globally Outstanding** in terms of biological distinctiveness, and **Vulnerable** in terms of conservation status (Thieme *et al.* 2005). It is recognised by LakeNet[50] as one of the top 250 lakes in the world for biological diversity, and the lake is generally recognised in the conservation community as near the top of the list of "wetlands of international importance" which are not yet Ramsar sites (see, e.g., Barker 2004). However, as yet Ethiopia is not a Party to the Ramsar Convention, and none of the internationally important wetlands around the lake have any official protected area status or management. Locally a few small areas have received protection for historical or cultural reasons, such as the wooded Zege peninsula near Bahir Dar, the Tara Gedem forest near Addis Zemen, and trees in church compounds, but these are exceptions.

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47 The geographical description of this IBA is not very precise.

48 Abebe Getahun & Dejen (in press) will report that there are 17 *Labeobarbus* species in the lake, not 16.

49 The only other cyprinid species flock was in Lake Lanao in the Philippines, but this is reported to have been wiped out by over-exploitation (Eshete Dejen 2008).

50 LakeNet: a US-based international NGO dedicated to lakes: http://www.worldlakes.org/index.asp

4.3.2 Habitats and Vegetation

4.3.2.1 Lake Tana

Ecologically Lake Tana can be categorised into three zones based on light penetration and distribution of life forms in the lake. These are the pelagic, sub-littoral and littoral zones (Eshete Dejen, 2003):

- Pelagic zone: this is the relatively deep water zone occupying about 70% of the lake area, with water depths of 8-14 m. Below 8 m light penetration and primary production are greatly reduced, and fish feed on dead and decaying matter.
- Sub-littoral zone: this zone covers about 20% the lake area with water depths of 4-8 m. The open water is penetrated by light and harbours phytoplankton and zooplankton, but no macrophytes (aquatic plants).
- Littoral zone: the shallow littoral zone (water depth 0-4 m) is relatively small, covering about 10% of the total surface area of the lake. Macrophytes are common in this highly productive zone, with swamps, lakeshore wetlands and river estuaries providing excellent habitat for fish, birds and other wildlife. Historically, the littoral was dominated by papyrus reed (*Cyperus papyrus*), common cattail (*Typha latifolia*) and common reed (*Phragmites karka*), with *Persica senegalensis, Vossia* spp., bulrush (*Scirpus* spp.) and *Nymphea lotus* common. However the extent of the papyrus beds has fallen dramatically in recent years and now it only remains in a few protected pockets, mainly on the southern shores of the lake, and specifically in the Chimba and Yiganda wetlands near and along the Gilgel Abbay River (Shimelis Aynalem 2009).

Lakeshore wetlands are located all around Lake Tana with the exception of the north-east. The littoral zone of the lake is bordered by low plains in the north (Dembia), east (Fogera) and south-west (Kunzila) that are often flooded in the rainy season. Together these wetlands and floodplains form one of the **largest wetland area in the country** and are an integral part of the complex Tana-ecosystem (Vijverberg *et al*. 2009)[51]. The wetlands are mapped in Figure 4-11, and are estimated by GIS analysis to cover 64,133 ha in areas of less than 1% slope (Note: additional wetlands exist in both the Dembia and Fogera Plains but have not been included in this total due to lack of appropriate imagery for the analysis).

Additional satellite imagery and analytical details are given in Annex 1 (Map 4)[52].

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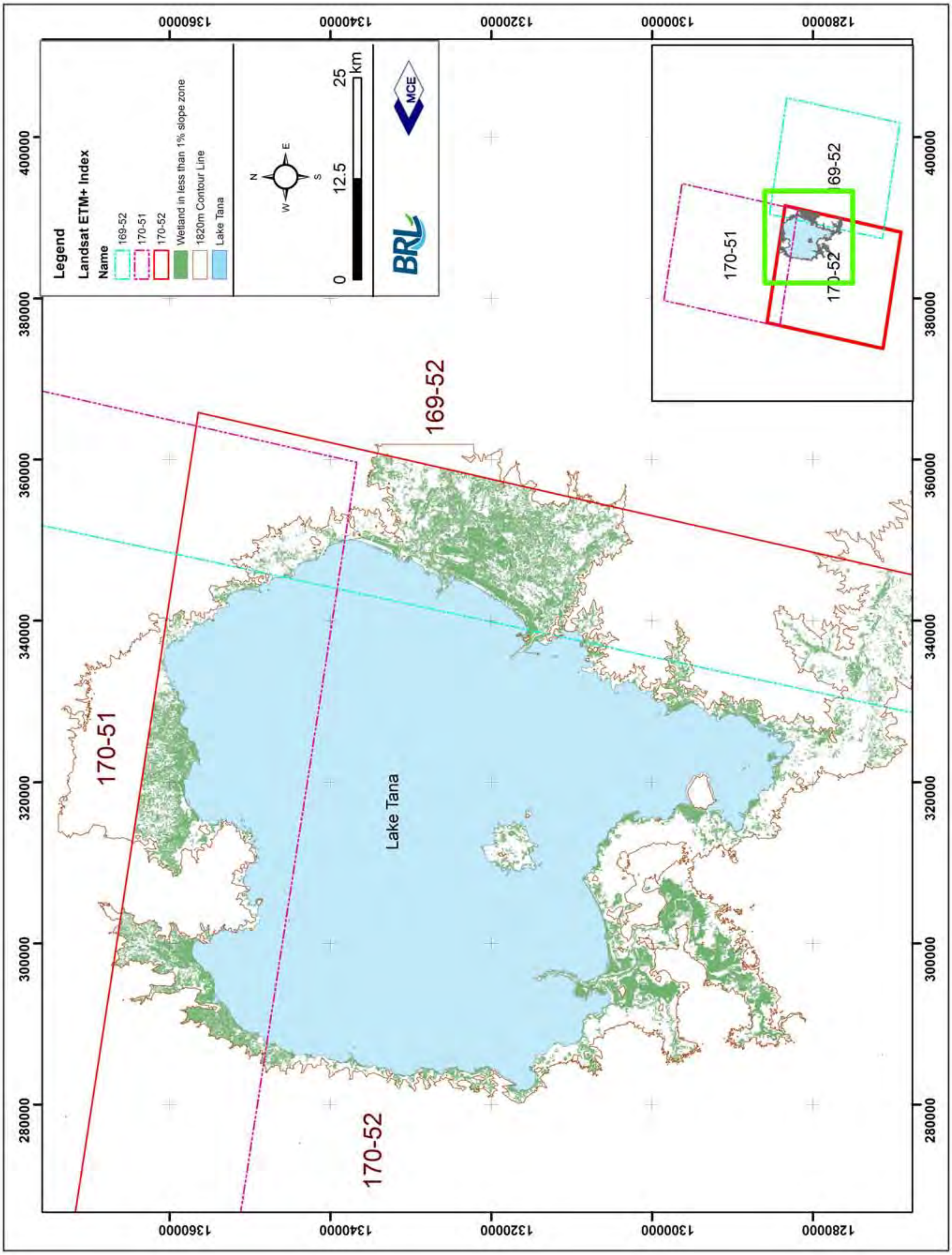
[51] Wetlands: as defined by the Ramsar Convention, wetlands are "areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres".

[52] The data layers comprising this map will be submitted to the MoWE, and will be important for future studies of the Lake Tana agroecosystem.

Figure 4-11: Lake Tana: Wetlands



Source: Consultant; see Annex 1.4 for derivation and for false-colour image

4.3.2.2 The Project Area

Five major habitat types are found in and adjacent to the Project Command Area (PCA): lakeshore wetland, riverine wetland, seasonally-flooded grassland, farmland and settlements, and scrub (Figure 4-12).

1. **Lakeshore wetland:** this occurs in a strip along the lakeshore from the mouth of the Old Megech River west to the outlets of the Dirma and Abakura Rivers, and then again in the bay between Kurtiye Hill and the pumping station site as far as Gorgora. The emergent macrophytes are dominated by bulrush or common cattail (*Typha latifolia*), *Panicum subalbidum, Persica senegalensis* and sedges (*Carex* spp.). Papyrus (*Cyperus papyrus*) is not present in this area. The main rooted floating plants are hippo grass (*Echinochloa stagnina*), *Ludwigia stolonifera* and *Nymphoides indica.* Hippo grass is attractive to the local hippopotamus population.

2. **Riverine marshes and river channels:** these are permanently wet areas around and along the courses of the major rivers in the area, especially along the Dirma River (Photo 4-5, Photo 4-6). The vegetation is dominated by grass of wet areas like marsh barbell Hygrophila schulii, Persica senegalensis, sedge (Cyperus spp.), floating (Ludwigia stolonifera) and submerged plants (Potamegon pectinatus). A few trees are still present along riverbanks, mainly Salix suserrata, Sesbania sp and a few figs (Ficus sycomorus). These areas are very important habitats for waterbirds, especially migrants such as the various Cranes. Note that the original riverine vegetation along the channels and banks of the Megech, Dirma, Kirsit and Nededit Rivers has been significantly modified or destroyed as a result of reduced or absent dry-season flow, removal of woody vegetation by browsing and for fuel, and cultivation.

3. **Seasonally flooded grasslands:** these are areas within the PCA which flood every year due to rainfall, overbank flow in the rivers, and rises in lake level. They dry out completely during the dry season and are managed locally (kebele level) as community pastures (free grazing). In the wet season they are important for some fish and for birds. The grassland vegetation includes species known locally as *Humya, Serdo, Gumarie sar, Chew tamie, Chiklika, Gingra* and *Asendabo* (Akalu Teshome *et al.* 2009), but as a result of overgrazing unpalatable species such as *Hygrophila auriculata* (*Amekyla*) and *Xanthium strumarium* (*Yemogn fikir*) are spreading. They are sprinkled with few rare acacia trees (*A. abyssinica, A. seyal, A. asak*).

4. **Farmland and settlements:** virtually all the command area is cultivated, as is all land elsewhere where the soil has any chance of supporting a crop. The fields are not separated by fences or hedges and have very low value as habitat, except for some birds and other animals which feed on cereal crops (sorghum, teff, maize, millet). The settlements are mostly surrounded by young eucalyptus trees, the universal building material and source of fuelwood and scattered acacia shrub. Eucalyptus trees are of low biodiversity value except as sources of pollen and nectar for honeybees. Structural diversity and some mature indigenous trees are found in the church compounds scattered throughout the area at distances of several km. Here some remnant Evergreen Montane vegetation may be found (predominantly *Olea* spp., *Cordia* spp. *Albizia* spp).

5. **Dry evergreen thicket and scrub:** scrub-land habitat occurs mainly to the west and north-west of the pumping station site, and on the hills to the west of the Dirma River. Mainly composed with herbaceous and shrub woody plants such as figs (*Ficus ingens* and *F. sycomorus)*, *Lantana camara, Acacia* spp. and *Albizia gummifera*, *Erythrina abyssinica*. The scrub-land is highly degraded due to browsing, fire and fuelwood collection.

Figure 4-12: Main Habitat Types in Project Area

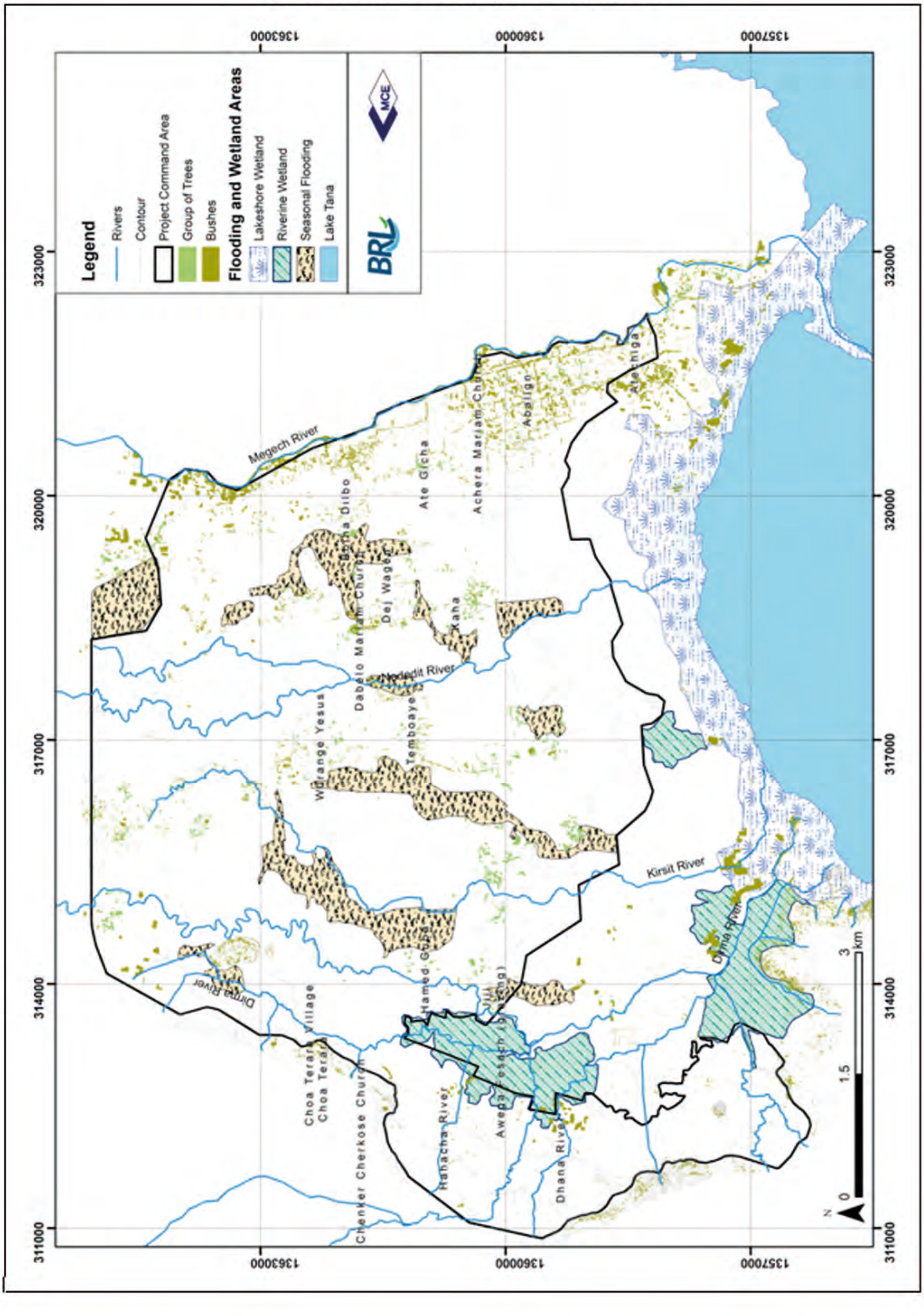


Photo 4-5: Riverine marsh near lake, north-east of Kurtiye Hill, between Abakura River (foreground) and Dirma River (by trees in background)

Photo 4-6: Same marsh subject to high grazing pressure in dry season

True forest is lacking in the study area. The only remnant forested sites nearby are pockets in the Gorgora port area. Woody plants here and in protected locations elsewhere may include *Agam* (*Carissa edulis*), *Bissana* (*Croton macrostachysus*), *Sesa* (*Albizia* sp.), *Warka* (*Ficus vasta*) and other figs including *F. thonningii*, *Wanza* (*Cordia africana*), *Kegga* (*Rossa abyssinica*), *Shola* (*Ficus sycomorus*), and *Girar* (*Acacia abyssinica*).

Plant species recorded in the study area by the ESIA team's specialists are listed at Annex 5.The extent of the key habitats of the study area is presented in Table 4-5 below, and their location is shown in Figure 4-12. Wetlands in and directly adjacent to the PCA - mainly along the Dirma River and the lakeshore - comprise some 20% of the core study area, and some 12% of all the wetlands around the lake. For comparative purposes, Table 4-6 shows the land use within the project command area in four major categories as determined by the RAP study (SMEC 2010).

Table 4-5: Main habitat types in and adjacent to Study Area

	Habitat Type	Area (ha)	Proportion of Study Area (%)
1	Lakeshore wetland	695	9
2	Riverine wetland	379	5
3	Seasonally flooded area	452	6
4+5	Other (farmlands, settlements, scrub)	6,303	80
Total area studied (Project Command Area and immediate surroundings)		7,829	100

Source: Consultant

Table 4-6: Land use in Project Command Area

	Land Use	Area (ha)	Proportion of Study Area (%)
1	Farmlands	4,579	89.1
2	Forest (public / private)	147	2.9
3	Grazing (communal) land	387	7.5
4	Buildings (structures)	28	0.6
	Total	5,141	100

Source: RAP (SMEC 2010)

4.3.3 Wildlife

4.3.3.1 Birds

Lake Tana: birds are relatively well known and documented as compared to other animal groups in Ethiopia. A number of bird surveys have been carried out in the Lake Tana area, in connection with the identification and monitoring of IBAs, or for investigating particular species at risk such as Cranes, or for academic research. Some of these surveys have included observation sites in and adjacent to the MPIDP command area. The following account is a compilation of data from these sources (principally EWNHS 1996, 2001; Nega Tassie 2007; Nega Tassie & Afework Bekele 2007; Nowald *et al.* 2007; Francis & Shimelis Aynalem 2007; Birdlife Int. & NABU 2009; Shimelis Aynalem 2009).

Located in the Horn of Africa, Ethiopia is an important link for migratory and gregarious species on their passage between Eurasia, the Middle East and sub-Saharan Africa. Lake Tana is a key location on these flyways, both for transit and as a winter destination for feeding and breeding. To date some 213 bird species have been recorded around Lake Tana by various surveys, with aquatic or wetland birds the most diverse group[53]. Most of these are migratory but some are resident.

Some lakeshore birds are piscivorous: the Great White Pelican (*Pelecanus onocrotalus*), Great and Long-tailed Cormorants (*Phalacrocorax carbo* and *P. africanus*), Hammerkop (*Scopus umbretta*) and the African Fish Eagle (*Haliacetus vocifer*), while others are non-piscivorous, e.g. Egyptian Goose (*Alopochen aegyptiaca*), Pygmy Goose (*Nettapus auritus*), and Spur-winged Goose (*Plectropterus gambensis*).

As noted earlier, surveys by EWNHS and their international partners (Birdlife International, Royal Society for the Protection of Birds (UK), Nature and Biodiversity Conservation Union (NABU: Germany)) have identified Lake Tana as an IBA based on IBA criteria A1 and A3[54] (Birdlife International 2009), specifically the presence of globally threatened species such as Wattled Crane, Lesser Flamingo and Greater Spotted Eagle, resident endemics with restricted ranges such as Rouget's Rail and Ankober Serin, and the presence of significant proportions of global populations of some waterbirds - estimates vary, but one observer considers that the population of birds around Lake Tana is likely to exceed 100,000

53 A wetland bird is one for which wetland is important for at least one stage in its life cycle. Those birds are ecologically dependent on wetlands.

54 BirdLife IBA Factsheet, ET007 Bahir Dar-Lake Tana, available from http://www.birdlife.org, accessed 18.09.2009.

seasonally (Shimelis Aynalem 2009), of which 83 are wetland species (Francis & Shimelis 2007). 19 highland biome species have been recorded in the area, including Abyssinian Long-eared Owl, White-backed Black Tit, White-throated Seedeater and Banded Barbet (EWNHS 1996).

Lake Tana and the Fogera Plains are closely linked ecologically, and in the view of qualified observers the two IBAs should be combined, together with the Infranz wetland, into one functionally linked IBA (Francis & Shimelis Aynalem 2007). Summary descriptions of the two existing IBAs (Bahir Dar-Lake Tana and Fogera Plains) are given at Annex 5.4.

Recent surveys of Cranes in Ethiopia sighted 94% of the national total of Black Crowned Crane at Lake Tana (1102 out of 1171 individuals), leading to the conclusion that **Lake Tana can be considered the most important wintering site for Black Crowned Crane** and that its conservation status should be upgraded (Nowald *et al.* 2007).

Dembia Plain: the MPIDP is situated on the northern shore of Lake Tana in the western part of the Dembia plain, one of the major floodplains around the lake. This has been less well investigated than the Fogera Plains east of the lake. Nevertheless so far surveys have identified 193 species of birds of 18 orders and 64 families in the Dembia Plain (Nega Tassie & Afework Bekele 2007). The great majority of these are waterfowl that inhabit, breed and forage on or near the marshes and the water. Some passerine birds[55] were present in farmland and along the rivers.

The records include 1 Ethiopian endemic: Yellow-fronted Parrot; 4 biome-restricted species: Wattled Ibis, White-collared Pigeon, Black-winged Lovebird and White-cheeked Turaco; 1 globally Vulnerable species, Wattled Crane; and 3 globally Near-Threatened species, Pallid Harrier, Black Crowned Crane (Photo 4-7, Photo 4-8) and Black-tailed Godwit.

With respect to wetland birds, notable counts were 524 Egrets (mostly Cattle but also Great White), 3 Goliath Herons, 7 Woolly-necked Storks, 258 Spur-wringed Geese, 271 Crowned Cranes, 282 Ruff and the large total of 1,762 White-winged Black Terns.

Photo 4-7: Black Crowned Crane by Nededit River in command area, Feb. 2009

Photo 4-8: Black Crowned Cranes, lakeshore between Dirma and Nededit Rivers, Feb. 2009

55 Passerine bird: belonging to the very large Order *Passeriformes*, or more simply and less accurately perching birds or songbirds.

Core study area: significant surveys in the study area are (i) Nega Tassie's 2006-2007 surveys of the Dembia Plain including areas along the Dirma River (Nega Tassie 2007), (ii) the 2007 IBA bird count which included three observation sites in the project area (No. 14 Gorgora/Seraba along the lakeshore, No. 18 Gorgora/Dirma River (north) covering wetlands along the Dirma River, and No. 19 Dirma River/Gorgora (west) covering the marsh at the Dirma River outlet: see Annex 5.3) (Francis and Shimelis Aynalem 2007), and (iii) the annual Crane count (Shimelis Aynalem 2009).

The 90 bird species identified in the core study area during these surveys are noted in Annex 5.3.2. These include three globally Near Threatened species, the Black Crowned Crane, Pallid Harrier, and Black-tailed Godwit, but no endemic or biome-restricted species.

Bird observations by the ESIA field survey team in 2009 are also noted in Annex 5.3.2. They included the Black Crowned Crane.

Nega Tassie's 2006-2007 study highlighted the differences in bird behaviour during the wet and dry seasons. It appears that the diversity of habitats in the study area is important in providing requirements such food, water and cover in different seasons (Nega Tassie & Afework Bekele 2007). Species preferentially recorded in the wetlands related to rivers included, e.g. Senegal Wattled Plover and Kittliz's Plover, Pratincole, Common Snipe, Black-winged Stilt, Avocet, African Spoonbill and Pallid Harrier and Montagu's Harrier. The Dirma and lakeshore wetlands are important for both significant numbers of Black Crowned Crane and Common (Eurasian) Crane.

In terms of diversity, the Dembia plain and core study area represent 91% and 45% of Lake Tana's overall bird diversity, respectively (Table 4-7). This diversity is comparable with the Fogera Plain (207 species recorded during the wet and dry seasons *cf.* A. Moges, 2008), which has been formally identified as an IBA.

Table 4-7: Bird Diversity - Core Study Area, Dembia Plain and Fogera Plain

Records / Location	Number of species	% of the diversity of Lake Tana	Number of Orders	Number of Families
In the whole Dembia plain	193	91%	18	64
In the core study area *(command area and immediate surroundings)*	92	43%	12	34
In the Fogera Plain	207	97%	20	64

Source: Nega Tassie (2007); Nega Tassie & Afework Bekele (2007); completed by ESIA investigations

By itself the core study area probably does not constitute "critical habitat" for birds in the sense implied in WB OP 4.04, but this is a matter of interpretation: the area is clearly important for some Near Threatened species, and forms a part of the overall Lake Tana wetland ecosystem which is of very high national and international importance.

4.3.3.2 Current Threats to Birds in the Study Area

Threats to birds identified by various observers include, in order of priority:

- Habitat loss due to conversion of natural and semi-natural habitats to cultivation.
- Habitat degradation by fire, over-exploitation of vegetation (pulling grass, cutting and digging papyrus, fuelwood collection), grazing, drainage, changes in hydrology, and sedimentation: the great majority of the bird species in the study area are waterfowl that inhabit, breed and forage in or near the marshes and the water; during the rainy season, both the breeding sites and ground nesting areas are affected.
- Disturbance and harassment, especially by children, but also by farmers who consider some birds to be pests, predating their crops.
- Changes in agricultural practices, specifically double cropping, leaving no time between crops for birds to forage for spilt or remaining grain.

4.3.3.3 Mammals

Information on mammals in the area has been obtained by direct observation during field surveys, by discussion with local informants, and through a review of relevant literature. Animals observed in the Dembia Plain are listed in Annex 5.5 (Nega Tassie 2007).

The lakeshore habitats and associated wetlands harbour two aquatic mammals, Hippopotamus (*Hippopotamus amphibious*) and (possibly) Clawless Otter (*Aonyx capensis*). 19 hippos (17 adults and 2 young) were observed around the old mouth of the Megech River in January 2009. 16 hippos were observed east of the Megech River and south of Robit during the 2007 IBA bird count (Francis & Shimelis Aynalem 2007). Local residents report that hippos frequent the lakeshore near the site of the pumping station, especially from late March to June when lake levels are at their lowest. At this time they graze in the Gorgora Hotel compound, where management and guards report that as many as 10 or more can be seen grazing the hotel from dusk to dawn. Hippos disperse to other areas as water levels rise at the onset of the rainy season, but their precise movements and territorial limits have not been mapped.

The lakeshore wetland is clearly "critical habitat" for hippopotamus, although it has been severely degraded in the last decade.

Other mammals reportedly commonly encountered in the study area include Porcupine (*Hystrix cristata*), Jackal (*Canis mesomelas*), Duiker (*Sylvicapra aethiops*), Olive baboon (*Papio anubis*) Vervet Monkey (*Cerapithecus aethiops*), Aardwolf (*Proteles cristatus*) and Aardvark (*Orycteropus afer*). Aardwolf is said to be common in the Gorgora area, especially in packs near the church (Tim and Kim Otte-de-Hoop, pers. comm.). Additional animals reported by Nega Tassie (2007) in the Dembia Plain area are Serval (*Felis serval*), Civet (*Civettictis civetta*), Genet (*Genetta sp.*), and Spotted Hyaena (*Crocuta crocuta*).

West of Gorgora the black and white Colobus monkey (*Colobus guereza*) sometimes occurs where there are big trees near the lakeshore.

4.3.3.4 Reptiles and Amphibians

The Nile Monitor (*Varanus niloticus*) is known to occur in the area. African Rock Python (*Python sebae*) may be encountered in wetlands; this snake is diminishing in numbers across its very wide range, and has been placed on CITES Appendix II (trade limitations). A python is reported to have been killed near the Gorgora Port premises by farmers in 2008. Other snakes are present but not surveyed.

The presence of many tadpoles in the Dirma River and its tributaries during the 2009 dry season fish survey (see Section 4.3.4) indicates the presence of frogs, but as yet the species present are undetermined.

There are no crocodiles in Lake Tana.

4.3.3.5 Other Animals

Fifteen species of Gastropods (snails and slugs) are associated with the macrophytes of the shoreline include the endemic subspecies *Bellamaya unicolor abyssinica,* and also *Bulinus* spp. which is host to *Schistosoma haematobium*, the trematode causing one form of Bilharzia (schistosomiasis).

4.3.3.6 Wildlife Pests

In addition to the ubiquitous House Mouse (*Mus musculus*) and Black Rat (*Rattus rattus*) which cause major damage to stored crops, a number of other vertebrates are considered pests in the area:

- **Birds,** especially Cranes and Geese, sometimes forage in standing crops before harvest, bringing them into conflict with farmers. Although in Ethiopia birds (like other wildlife) are protected by religious customs and (to a small extent) by law, farmers may harass and persecute birds attacking their crops.
- **Hippopotami** are not appreciated by local farmers, since they destroy crops and, reportedly, compact soil making cultivation difficult. The ESIA study team was informed that in June 2008 a farmer shot a Hippopotamus that destroyed his crops; apparently he was not reprimanded by the authorities.
- **Aardwolves are** reported to have attacked human beings in daylight two years ago. This report cannot be verified.

- **Porcupine** used to be a menace in what is presently Wawa Farm, destroying crops. Since Porcupine lie up in Aardvark dens during the day, the menace was controlled by putting a price of ETB 30 on termite queens, encouraging young men to dig them out, thus reducing the number of termite colonies and consequently the numbers of Aardvark which feed on termites and hence the number of Porcupine-friendly Aardvark dens.
- Other areas around Lake Tana report crop damage from Vervet Monkey and Baboon, and night-time predation by Hyaena, but these animals do not appear to cause significant problems in the core study area.

4.3.4 Aquatic Ecology and Fisheries

4.3.4.1 General

The fisheries ecology of Lake Tana is becoming increasingly well known, and at the same time the pressures on the system are rapidly increasing. Scientific interest centres on the endemic barbel population (*Labeobarbus* spp.) which has speciated within the lake and of which many species spawn in the tributaries and headwaters of the rivers feeding the lake (Box 4-1, Figure 4-13).

Box 4-1: Labeobarb Reproduction in Lake Tana

Labeobarb Reproduction in Lake Tana

In Lake Tana the genus *Labeobarbus* is represented by 16 species of which 15 are endemic to the lake and belong to **a unique species flock of endemic cyprinids**.

The speciation was possible because the lake offered new habitat for adaptive radiation and maintained its isolation from the rest of the Abbay system due to the 40 m high Tis Issat Falls at the outlet of the lake.

At least seven of the *Labeobarbus* species are known to spawn in the headwaters of the main rivers feeding the lake. Highly oxygenated water and gravel beds are general requirements for *Labeobarbus* spawning due to their critical importance in the development of eggs and larvae. Deposition of eggs in gravel beds prevents them from being washed away and clear water prevents them from being covered by sediment which might obstruct the diffusion of oxygen. After a brief pre-spawning aggregation on the river mouths, final maturation and spawning occur in the tributaries of the major rivers, or possibly at gravel reaches in the main channels.

The adults migrate upstream in July-August at the onset of the rainy season and higher flows. After completing spawning they return to the lake for feeding until the next cycle of breeding.

The specific requirements of the nursery grounds and the duration of return of the juveniles are not well documented. Nevertheless, it is known that juveniles follow the adults returning to the lake in September-October as flows reduce to feed and grow until they become sexually mature.

The most detailed work on Labeobarbus spawning has been carried out on the Gumera River on the south-east side of the lake, which is a favoured *Labeobarbus* spawning river. Limited surveys in the study area indicate that **the Megech and Dirma rivers and their tributaries provide ideal breeding grounds for the Labeobarbus species in the northern part of the lake**, as does the Gumera river in the south: five of the *Labeobarbus* species were found to migrate from Lake Tana up both the Megech and Dirma Rivers to spawn (Wassie Anteneh 2005), although with some preference in numbers for the Megech which more tributaries with gravel beds and a slightly higher dissolved oxygen content (Figure 4-13, Photo 4-9).

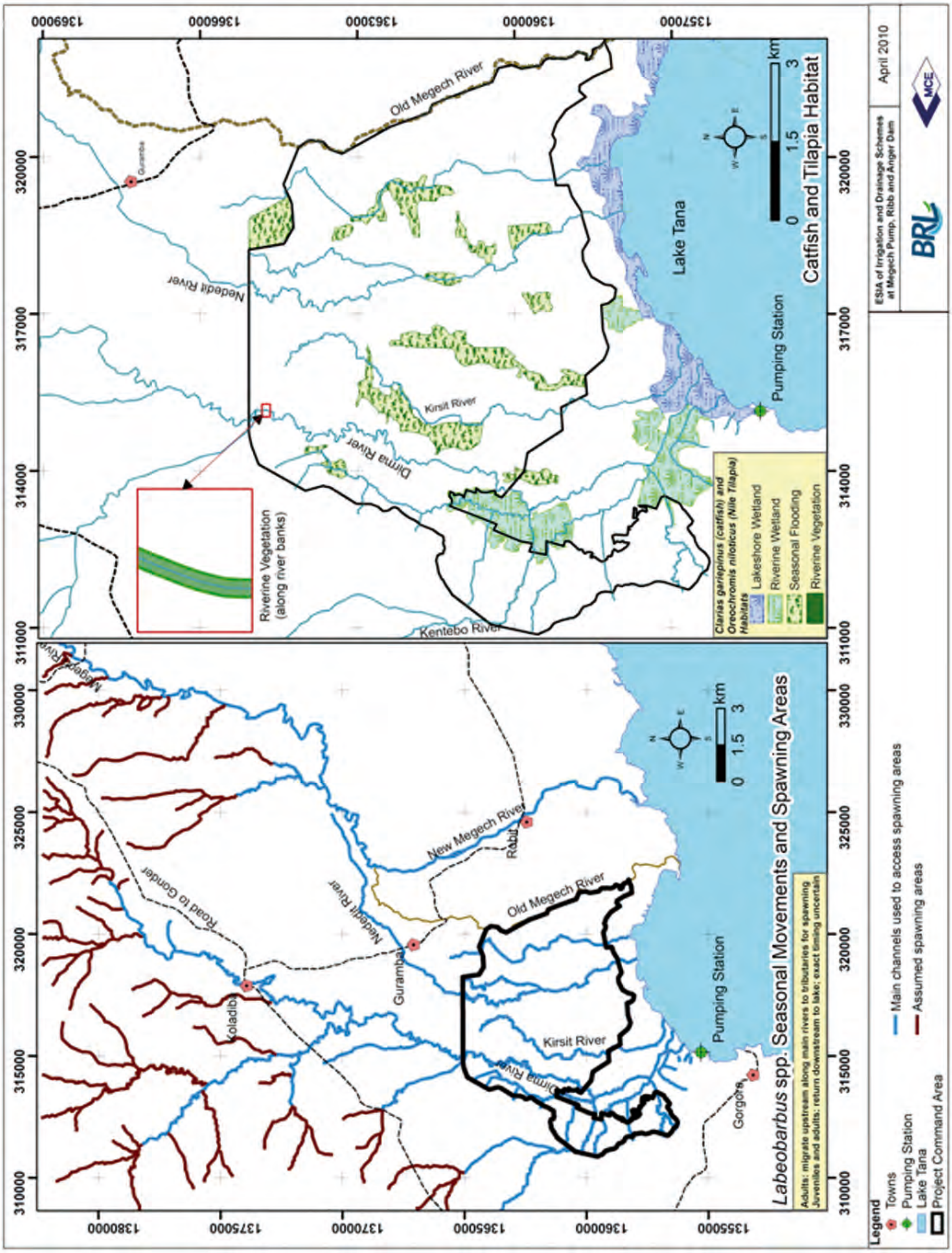
There is some evidence that the *Labeobarbus* species may be divided into three categories of reproduction (Wassie Anteneh 2005):

- Obligatory riverine spawners
- Generalists (spawning in both the lake and its tributary rivers)
- Lacustrine spawners

As yet there is no evidence of river-specificity for the riverine spawners, but this cannot be discounted.

The recent survey of the Dirma River for this study suggest that some pools in the main river channel may serve as habitats for feeding and reproduction of some fish including river resident *Labeobarbus* spp., Catfish (*Clarias gariepinus*), Nile Tilapia (*Oreochromis niloticus*), small *Barbus* and *Garra* spp.

Figure 4-13: Fish Habitat in Project Area



4.3.4.2 Characterisation of the Waterbodies

The study area is composed of the following water bodies:

1. **The Lake:** Lake Tana is Ethiopia's largest lake, containing half the country's freshwater resources, and the third largest lake in the Nile Basin.

   The lake waters are shallow and well mixed, with no thermocline. The lake is categorized as oligo-mesotrophic. Its turbidity is high and the suspended sediments reduce underwater light intensity and hence primary production, the basis of the food chain. Thus although the lake is mesotrophic in terms of its water chemistry, it is oligotrophic based on primary production.

   The fish community of the lake is dominated by cyprinid fishes represented by 4 genera. There is only one cichlid, Nile Tilapia (*Oreochromis niloticus*), which is widespread in Africa. The Catfish family is also represented by a single species (*Clarias gariepinus*), a common species. **19** of the 27 fish species of Lake Tana are **endemic** to the lake and therefore to Ethiopia (Vijverberg *et al.* 2009). In the case of *Labeobarbus* **15 species are endemic**[56] and belong to a **unique species flock of endemic cyprinids**.

   During the rainy season the wetlands around the lake are connected to it and act as nurseries for most of the fish populations in the lake, as well as providing breeding habitats for waterfowl and mammals. Many of the *Labeobarbus* species and certainly three other commercially important fish species, Nile Tilapia (*Oreochromis niloticus*), African catfish (*Clarias gariepinus*) and Beso (*Varicorhinus beso*) spawn here and their juveniles feed and grow during the first years of their life.

2. **Megech and Dirma Rivers:** the Megech and Dirma Rivers are the main rivers in the northern part of the lake.

   The Megech River (Photo 4-9) originates near the Simien Mountains National Park at an altitude of some 3500 to 4000 m asl. During the rainy season, the Megech is on the average about 10-15 m wide and may be 1.5-2.5 m deep in places. Much of the water in the river is diverted for irrigation upstream of the PCA, and the river may run dry in some dry seasons. Some 15 years ago it changed its course, so that the river now runs past the village of Robit and the mouth is now some 5 km further east. The old river channel forms the eastern boundary of the project command area, and in theory should not be physically affected by the project.

   Photo 4-9: Megech River upstream of Bahir Dar-Gonder road; note clear water and gravel bed

   The Dirma River and its main tributaries originate at altitudes between 2500 and 3000 m asl. It has a length of some 60 to 65 km. Downstream from Kola Diba town the river is joined by several small streams and runs slowly through the alluvial Dembia plain until it joins Lake Tana. The river's upper reaches (upstream from Kola Diba Bridge) have a channel comprised of boulders, pebbles and gravel beds which is good habitat for spawning *Labeobarbus*. The Dirma's most important tributaries are on its right (west) bank. Most cross the Gonder - Kola Diba - Gorgora road. The 10 most important were recorded (see Annex 6.1).

[56] Or possibly 16 out of 17: see Abebe Getahun & Dejen (in press).

At the beginning of February 2009 there was still some flow in the channel near the lake, although in small quantities.

3. **Other rivers:** the Kirsit River is some 1-2 km east of the Dirma River and was completely dry when inspected in Feb. 2009. Local residents reported that this river floods during the rainy season and maintains its connection to the lake up to September or October.

   The Nededit River is a little bigger than the Kirsit and is located some 3 km further east. The river borders two kebeles, Seraba Dabelo and Achera Mariam. It originates from Merew hill in Sufankara Merew Kebele near Kola Diba town. By the lake, farmers have excavated the bed of the Nededit to lead water from the lake back into the proposed command area, for dry season irrigation.

   The small Abakura River is immediately west of the Dirma River and enters the lake independently, although there are some man-made cross connections between the two rivers. The greater part of the Abakura has little or no water in the dry season.

4.3.4.3 Phytoplankton, Zooplankton and Crustaceans

According to Vijverberg *at al.* (2009), the phytoplankton of Lake Tana are dominated by Cyanobacteria in the post-rainy season and diatoms in the pre-rainy season.

A large proportion of the annual primary production of the lake occurs in a short two-month season after the rains (October-November), limiting the transfer of matter and energy between the first and second trophic levels of the lake ecosystem (Vijverberg *et al.* 2009).

Zooplankton is dominated by Cladocerans (9 species) and Copepods (4 species) with a nearly equal contribution in their relative abundance. The calanoid copepod *Thermodiaptomus galebi lacustris*, the dominant zooplankton in the lake, is endemic to Lake Tana. The zooplankton community structure of Lake Tana is unusual for tropical lakes because of its relatively high percentage of temperate species (*Daphnia hyaline* and *Ceriodaphnia dubia*).

The largest crustaceans are freshwater crabs of the genus *Potamonautes*, but as a riverine species they are fairly rare in the lake. A freshwater medusa (*Limnocnida indica* or *L. tanganjikae*) is regularly observed.

Bivalves, midges (e.g. *Chironomidae*), annelids and various flies (e.g. *Ephemeroptera*, *Plecoptera*) are abundant at the Megech and Dirma River mouths.

4.3.4.4 Fish in the Study Area: Diversity, Abundance and Habitats

Fish Diversity

During the ESIA field survey (see Section 1.3.7.2)) 16 species of fish were collected and identified from six sampling sites in and adjacent to the project command area, representing 3 families and 6 genera (Table 4-8). 10 of the species are endemics officially proposed for IUCN Red List Endangered status.

The majority of these species (10) belong to the genus *Labeobarbus* (large barb species). This is about 60% of the total *Labeobarbus* species known from Lake Tana (17 species). Other species that found in waters of the project area included *Oreochromis niloticus, Clarias gariepinus, Varicorhinus beso, Barbus* spp. and *Garra* spp.

- Most of the *Labeobarbus* species were found in the lake rather than the rivers as the sampling period was not a breeding season and no migratory behaviour was occurring. The Dirma River has been confirmed as a spawning site for some *Labeobarbus* species, but wet-season *Labeobarbus* use of the other, smaller rivers in the project area (Nededit, Kirsit) is lacking.
- Nile Tilapia *(Oreochromis niloticus)* is found in the lake and is assumed to breed in the littoral zone and in adjacent small rivers including the Dirma, Nededit and Kirsit (the Kirsit River was completely dry during the survey period (January 2009)). Tilapia are known to spawn in riparian vegetation, e.g. lake margins, throughout the year with a peak in March-April; the vegetation also acts as nursery area for juveniles (Tadesse, 1997). Usually juvenile Tilapia are common in the littoral zone.
- Catfish *(Clarias gariepinus)* is abundant around the lake and breeds in the littoral zone and lakeshore wetlands as well as connected wetlands in the floodplains, especially during the rainy season.

Many of the fish species (11) were collected from Site 1 which is the proposed site of the pumping station. Sites 2 (Dirma river mouth) and 5 (Dirma river lower reaches – Wawa farm) were also important in terms of diversity.

Table 4-8: Total and Relative Abundance of Fish Caught in the Study Area and their Conservation Status

Family	Genus and Species	No. of Specimens & % Composition		Status	Conservation Status*
Cyprinidae	*Barbus humilis*	193	35.7%		Least concern
	Barbus tanapelagius	9	1.66 %	Endemic	Endangered
	Garra dembecha	110	35.7%	Endemic	Least concern
	Labeobarbus acutirostris	3	0.55%	Endemic	Endangered
	Labeobarbus brevicephalus	9	1.66 %	Endemic	Endangered
	Labeobarbus crassibarbis	1	0.185%	Endemic	Endangered
	Labeobarbus gorgorensis	2	0.37%	Endemic	Endangered
	Labeobarbus intermedius	15	2.77%		Least concern
	Labeobarbus megastoma	4	0.74%	Endemic	Endangered
	Labeobarbus platydorsus	1	0.185%	Endemic	Endangered
	Labeobarbus surkis	1	0.185%	Endemic	Endangered
	Labeobarbus truttiformis	1	0.185%	Endemic	Endangered
	Labeobarbus tsanensis	20	3.70%	Endemic	Endangered
	Varicorhinus besso	4	0.74%		Least concern
Clariidae	*Clarias gariepinus* (Catfish)	16	2.96%		Least concern
Cichlidae	*Oreochromis niloticus* (Nile Tilapia)	152	28.15%		Least concern

* Proposed by IUCN Freshwater Fish Specialist Group in 2009 to IUCN Red List Authority

Note: the fish survey was carried out in the dry season with low or no flow in the river channels and little to no breeding behaviour.

Source: Consultant

Fish Abundance

The most abundant species was *Barbus humilis* collected from the rivers. Nile Tilapia (*Oreochromis niloticus*) and *Garra* spp. were the second and third most abundant species, respectively.

Among the *Labeobarbus*, the most abundant species were *L. intermedius*, the only non-endemic *Labeobarbus* species and common in all Ethiopian lakes and rivers and *L. tsanensis*, an endemic.

The results from each sampling site are listed in Annex 6.3.2. 89% of the individuals caught were in the rivers, with only 11% caught in the lake or at the mouth of Dirma River (Photo 4-10). This is related to the presence of numerous juvenile fish in the rivers, which have many nursery niches, and also to it not being a breeding season for *Labeobarbus* species.

In terms of maturity (see the data in Annex 6.3.1), the presence and the samples of *V. beso* and *O. niloticus* may be explained by their year-round breeding. The advanced maturity of some of the *Labeobarbus* individuals in January was unexpected and cannot easily be explained, since they are known breeding during the rainy season (July-September). It may be that these species are using a different reproductive strategy, which requires further investigation.

Photo 4-10: Labeobarbus spp. caught in Lake Tana near mouth of Dirma River, dry-season fish survey, Feb. 2009

Mapping of Fish Habitats

Species of conservation and commercial importance are *Labeobarbus* spp., Nile tilapia (*Oreochromis niloticus*) and Catfish (*Clarias gariepinus*). Figure 4-13 shows the Dirma and Megech Rivers that are most important for migrating adult and juvenile *Labeobarbus*, i.e. adults migrating upstream from Lake Tana to spawning grounds in the upper catchment and tributaries, and juveniles migrating downstream to the lake.

Nile Tilapia primarily uses Lake Tana as habitat for all life stages, with some individuals being found in the lower reaches of Dirma and other rivers. It is the only species that was found in all sites sampled. Catfish was sampled at all riverine sites and one site in the lake signifying that the riverine habitats are well suited for feeding and breeding of catfish. Their breeding habitat can be considered to be essentially all the wetlands shown in Figure 4-11.

4.3.4.5 Fishery Economic and Livelihood Issues

Fishery in Lake Tana

The three main species groups targeted by the fisheries are the *Labeobarbus* spp., African catfish (*Clarias gariepinus*) and Nile tilapia (*Oreochromis niloticus*). *Labeobarbus* is the preferred fish group for home consumption due to its high fat (oil) content and fleshiness, requiring little oil for cooking. Tilapia and Catfish are preferred by hotels and urban residents around the lake because these fish are considered to have better flavour. The Lake Tana fisheries are described in Box 4-2. Seasonality is described in Table 4-9.

Box 4-2: Fishing in Lake Tana

Fishing in Lake Tana

Fishing in Lake Tana was started around the 18th century by the indigenous Negada-Woito community and then adopted by other lake area residents.

Until recently, all fishing was carried out by traditional reed boat (*tankwa*) made with papyrus. *Tankwas* are 3-4 m long, 60-100 cm wide, and have a life span of 2 weeks to 2 months, depending on use. They used to be made locally, but due to the extermination of most papyrus are now purchased in Bahir Dar for USD 2-4 (Gordon *et al.* 2007).

In 1982 an EC-funded Lake Fisheries Development Project started focusing on improved fishing technologies and upgrading the Fish Production and Marketing Enterprise's (FPME) processing and marketing capabilities. This included activities in Lake Tana. In 1986 a Lake Tana Fisheries Resource Development Programme (LTFRDP) was initiated by two Dutch NGOs (ISE-URK and ICCO-Zeist) in collaboration with the Ethiopian Orthodox Church and the Ministry of Agriculture. The programme aimed to help the poor fishers around the Bahir Dar Gulf area and nearby islands by introducing modern fishing gear and motorised boats. The program of motorisation was accompanied by organisation of the fishers into an association and training in net making, fish processing and engine maintenance.

The LTFRDP created new opportunities for the fishers, extending their fishing area from the shore to deeper, offshore waters and, more importantly, to distant river mouths. Moreover, with the increase in catch, fish processing, marketing and net making emerged as job opportunities for surrounding communities.

Currently, there are three major types of fisheries characterised by specific combinations of gear and fishing craft:

1. The motorised gillnet fishery (mesh sizes 10-14 cm) based in Bahir Dar and now expanding to all 10 Woredas bordering the lake, including the Gorgora area where the MPIDP is located.
2. The traditional reed boats-gillnet fishery (mesh size 6-12 cm) all around the lake.
3. The chase and trap fishery (mesh size 6-9 cm) based in the southern part of the lake.

Gear such as longlines, cast nets and traps are occasionally used but contribute little to the total fish catch.

The traditional reed boat fishery is still important for remote areas of the lake. Reed boats normally carry only one fisher and fish are caught in the early morning. The catch from this fishery is sold at small markets in local villages or used for household consumption, and the main target species is Nile Tilapia (*O. niloticus*). *Tankwa* fishermen use local gillnets, hooks and lines, traps and sometime spears to catch catfish.

The recently introduced motorized fishery mainly targets bigger markets, using motorised boats with 100 m long gillnets of 10-14 cm stretched mesh size. For the whole lake, there are about 25 motorised fishing boats, most of which land their catch in Bahir Dar (either directly or via collector boat).

The lake fishery employs more than 3,000 persons who are directly dependent on the major activities of fishing, marketing, and processing for their livelihoods. Most of these are in the southern part of the lake. In the northern part are about 85 full time fishermen organized in an association, and about 500 part-time fishermen and their dependants (Wassie Anteneh 2005).

Table 4-9: Seasonality in the Lake Tana Fishery (provisional)

Season	Comment
March - August	Highest catch levels from Lake Tana
November - May	Harvest period from seasonal ponds
January - July (especially March/April/May)	Tilapia important
June - September (especially June/July)	Catfish important
June - September (especially August)	Barbus (*Labeobarbus*) important, especially for subsistence

Source: Gordon et al. (2007), referring mainly to the east side of the lake and the Fogera Plain

Catches, especially for the northern part of the lake, are poorly documented and there is no reliable system for catch monitoring and reporting.

The commercial gillnet fishery of Lake Tana developed rapidly in that the total catch increased from 39 t in 1987 to 360 t in 1997 (Tesfaye Wudneh 1998) or between 470 and 1470 t/yr in 1992-1995 (BoARD in Gordon *et al.* 2007). The routine data collection and analysis systems established by the Lake Fisheries Development Project (2^{nd} Phase) were abandoned around 2000 (BoARD, in Gordon *et al.* 2007). No catch data from Lake Tana are available for subsequent years. Estimates of total annual catch vary from around 1,000 t (Gordon *et al.* 2007) to 3,000 t (BoARD: see Table 4-10).

Table 4-10: Lake Tana: Estimated Annual Fish Catch

Year	Annual Catch (t)
2003	1,068
2004	1,231
2005	1,281
2006	3,004

Source: ANRS BoARD estimates

Between the 1990's and 2007, the changing species composition of the commercial catch indicates a sharp decline of the endemic Labeobarbs compared to Catfish and Tilapia (Table 4-11).

Table 4-11: Lake Tana: Species Composition of the Commercial Catch

Species	1990's	2007
Labeobarbus spp.	40%	15%
African catfish	25%	21%
Nile tilapia	35%	64%

Source: ANRS BoARD

The Fish Production and Marketing Enterprise (FPME) is the only market outlet available for Lake Tana fishery. About 30% of the fish handled by FPME nationally is sourced from Lake Tana. Prices in 2007 are given in Table 4-12 (FPME 2007).

Some fish traders distribute fish only to local consumers to satisfy the local demand using the basic market channel (landing point to consumer). Recently, traders from around Lake Tana started exporting dried fish to Sudan. Most traders in dried fish marketing have not registered.

Table 4-12: Fish Prices in 2007

Type of Product	Prices (ETB/kg)					
	Tilapia		Catfish		Labeobarbus	
	Producer	Retailer	Producer	Retailer	Producer	Retailer
Wet whole fish	5	21	3	17	3	11
Dried fish			2	12.5	2	6.5

Source: FPME (2007)

Fisheries in and around the Project Area

In the northern part of the lake, around the project area, there is limited access to markets because the landing sites and towns are far apart and there is virtually no marketing infrastructure. Transportation of quality fresh fish to markets is a critical and limiting factor. Thus, the price of fish in this area is lower for the wholesalers and for the fishers alike.

According to interviews with fishermen around Gorgora in 2009, catfish were more valuable and saleable than fish from other groups. Catfish could be sold for ETB 6-10/kg while *Labeobarbus* spp. and Nile Tilapia sold for only ETB 2-3/kg and ETB 5-8/kg, respectively.

A trading point for dried fish en route to Sudan has developed at Chuahit, on the road between Kola Diba and Gorgora (Gordon *et al.* 2007). This is supplied by some 200 *tankwa*/day from all around the lake, including trading through the new trading point at Infranz (on the main road in the Fogera Plain). The main species is catfish.

Official figures for annual fish production in Dembia Woreda are given in Table 4-13. These should be considered approximate.

Table 4-13: Annual Fish Production, Dembia Woreda

Year	2003-4	2004-5	2005-6	2006-7	2007-8	2008-9
Production (t)	268	780	406	658	104	350

Source: Dembia WoARD, in Halcrow-GIRD (2010)

The majority of the catch around the project site comes from the traditional reed boat fishery. The introduction of the commercial gillnet fishery has not significantly affected the traditional fishery because it focuses mainly on fish collection from fishers rather than fishing itself. A local informant reports that the number and size of nets used by fishermen have increased in the last 10-15 years, and the mesh size has reduced. Specific fishing uses of the PCA rivers are given in Table 4-14.

Table 4-14: Fishing in PCA Rivers

River	Comment
Dirma	At Ahmed Guba village, Seraba Dabelo Kebele: people fish freely every day; nets are stretched across the river; catches include mostly Catfish with some Tilapia and *Labeobarbus*
Nededit	Achera Mariam Kebele: nets are stretched across the river; the kebele Development Agent confirmed that "fish have no chance to pass over it"
Dhana & Hahacha (Dirma tributaries)	Chenker Cherkose Kebele: nets are used, also traditional wooden fish traps; Catfish and small *Labeobarbus* are caught, but not Tilapia; people eat fresh fish several times per week in rainy season
Gilgel (Dirma tributary)	Choa Terrara village: nets are used; Catfish are taken but no *Labeobarbus*

Source: Consultant

In some parts of the PCA there is a ban on eating fish during periods of fasting (a significant portion of the year), but fishermen are allowed to continue their work. Fish tend to be a subsistence protein source, especially during the difficult period at the beginning of the rainy season, and especially for the poorest households. Sales of fish may bring in cash, with prices of fresh fish in Chuahit in the rainy season reported as ETB 4-5/kg. Catfish have a higher value than *Labeobarbus* species, apparently because of the demand for dried catfish in Sudan.

The conservative estimate of the potential yield of Lake Tana is about 10,000 t/yr and is made up of *Labeobarbus* species, tilapia and catfish. Of this about 20% is contributed by the *Labeobarbus* spp. (based on estimates made in the southern part of the lake), so the estimated potential contribution of Labeobarbs to the total production is about 2,000 t/yr.

Assuming that the *Labeobarbus* species migrate evenly to all the rivers around the lake and that tilapia and catfish feed and breed in the associated shore areas, wetlands and floodplains, it is estimated that about 1,500 tonnes of fish could be produced as a result of the proper functioning of the Dirma and other rivers and associated wetlands. In monetary terms, this translates to some ETB 4,500,000/yr (producer's rate) or ETB 16,500,000/yr (retailer's rate). Of this an estimated 300 t could be contributed by the Labeobarbs that spawn in the Dirma and adjacent rivers. In monetary terms, 300 t is about ETB 1,000,000/year (producer's rate) or ETB 3,300,000/year (retailer's rate). These numbers emphasise the high economic value of functioning wetland ecosystems around the lake.

Fisheries Social Organisation and Administrative Framework

Cooperatives are now emerging in the 10 Woredas surrounding the lake. Each Woreda is thought to have a minimum of one association with 80-120 members. In general it is estimated that 1,300 fishers may be organized in associations with modern fishing methods throughout the Lake Tana region. Accordingly, there are some (about 85) legally organised fishermen in Dembia Woreda, specifically in the Andenet Fishery Cooperative centred on Gorgora. However, the number of illegal fishermen (about 500) far exceeds the number of legally registered ones. Since the cooperatives are weak, it has become very difficult to control the illegal fishermen and hence the illegal exploitation of the fishery resource.

4.3.4.6 Ecological Value of the Study Area for Fish

Most large African cyprinids spawn by making a single annual breeding migration to upstream areas of rivers. This is the best indication that they are not fully adapted to lake environments. Studies conducted at four Lake Tana tributary river mouths (Gilgel Abbay, Gelda, Gumera, and Ribb) have shown this ancestral, riverine reproductive strategy to be characteristic for at least seven of the 17 *Labeobarbus* species of Lake Tana (*L. acutirostris, L. brevicephalus, L. macrophthalmus, L. megastoma, L. platydorsus, L. truttiformis*, and *L. tsanensis*). Of these, it has been suggested that three, *L. brevicephalus, L. truttiformis* and *L. tsanensis* (all recorded upstream in the Dirma and Megech Rivers) are obligatory riverine spawners, whereas four may be "generalist spawners" using both the rivers and the lake margins, and a further nine are lacustrine spawners (Wassie Anteneh 2005)[57].

Three other commercial important fish species (Nile tilapia, African catfish and Beso) spawn in the Dirma River (and related wetlands) and their juveniles feed and grow there during the first years of their life.

57 Wassie Anteneh was considering 15 *Labeobarbus* species. This number is now thought to be 16 or even 17, depending on author.

Considering their role as breeding sites and nurseries for at least 10 endemic and endangered[58] species of fish, together with their importance for maintaining stocks of more common but also commercially important fish, **the rivers and wetlands of the project area can be considered "critical fish habitat" in the sense implied by WB OP 4.04 *Natural Habitats***. The specific species of concern are the various Labeobarbs in the *Labeobarbus* species flock.

4.3.4.7 Current Threats to Fish in the Study Area

The current "without project" situation concerning fish in the project area is one of rapid negative change. The main factors affecting fish are loss of habitat and over-fishing:

- Loss of habitat is occurring in the Megech, Dirma and other rivers due to a combination of diversion of water during the dry season and sand mining (especially in the Megech). This results in physical obstructions, destruction of the river channels, and an absolute lack of water for any fish trying to return down-river to the lake from September onwards. Rapid habitat loss is also occurring as wetlands along rivers and the lakeshore are degraded and taken into cultivation.
- Overfishing is occurring especially through the use of gillnets at the mouths of the project area rivers during *Labeobarbus* spawning aggregations prior to migration up-river. *Labeobarbus* is highly vulnerable to this type of recruitment over-fishing: dramatic reductions (75%) in total abundance (both numbers and biomass) of six species of *Labeobarbus* adults and 90% in the number of juveniles were recorded in Lake Tana between 1991 and 2001 (de Graaf *et al.* 2004). The same authors report a drop in Catch per Unit Effort for *Labeobarbus* by the commercial gillnet fishery from 63 kg/trip in 1991 to 28 kg/trip in 2001. The contribution of *Labeobarbus* to the total fish catch has declined from about 40% in the 1990s to about 15% by 2007 (Abebe Getahun, pers. comm.).
- There is some evidence of poisoning of *Labeobarbus* spawning stock in the Gumera River using the crushed seeds of *Birbira* (*Millettia ferruginea*, an endemic leguminous tree) (Abebe Ameha 2004, in Eshete Dejen 2008), but this has not been observed in the study area.

4.4 Social and Economic Context

4.4.1 The Amhara People

The Amhara people are the highlanders of central and north Ethiopia (Shoa, Wollo, Gojam, Begemder), who live in the agro-ecological zones called "*dëga*" and "*waïna dëga*" (above 1,800 m). Before the beginning of Oromo migrations in the 16th century, they were the largest cultural group in Ethiopia.

A long time ago Lake Tana area was occupied by a variety of communities, characterised by different religions, different food habits and different occupations. For instance, in the 16th century the Dembia area was known to be the country of the *Falasha* people (the Ethiopians Jews). Ethiopia's turbulent history has included a strong '*amharization'* process intended to unify the country, challenged on many occasions by the numerous contrasting communities from elsewhere in the country.

The question of whether a distinctive ethnic group now referred to as "Amhara" exists is still controversial and intensively debated among Ethiopian scholars. As is often the case in ethnic differentiation, the name and the main cultural features of a group are given and identified by other groups who do not share the same features: the people perceived to be '"*Amhara*" are characterised by others for the uniformity of their culture, based on one religion (Orthodox *Tawohedo* Church), one language (*Amharic*) and one occupation (growing *teff*).

The Amhara people are intensely attached to their land, not least because this is the basis for their livelihoods, and therefore have some of the characteristics of an indigenous people in terms of the Bank's OP 4.10. However, their customary cultural, economic, social, or political institutions are not separate from those of the dominant society and culture, and the Amharic language is both officially recognized and widely used within the country. Consequently the Amhara people are not considered by the ESIA consultant to be indigenous people in terms of the Bank's policy.

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[58] Endangered in the literal sense, and formally proposed for listing as Endangered in the IUCN Red List.

Within the Lake Tana basin there is at least one group of inhabitants who would be considered indigenous people under the policy, the Woitos of Lake Tana. This group has traditionally been dependent on the lake's resources, especially fish and papyrus. During the last century their traditional way of life has been overtaken by external pressures, and they now form a distinct community of several thousand in the Bahir Dar area, but not near Gorgora.

4.4.2 Socio-economic Profile of Project Area

4.4.2.1 Project Woredas and Kebeles

The project is located in Dembia Woreda, the most populated woreda of North Gonder Zone, which is in turn the most populated zone among the 10 zones of Amhara National Regional State (ANRS) (Figure 4-14).

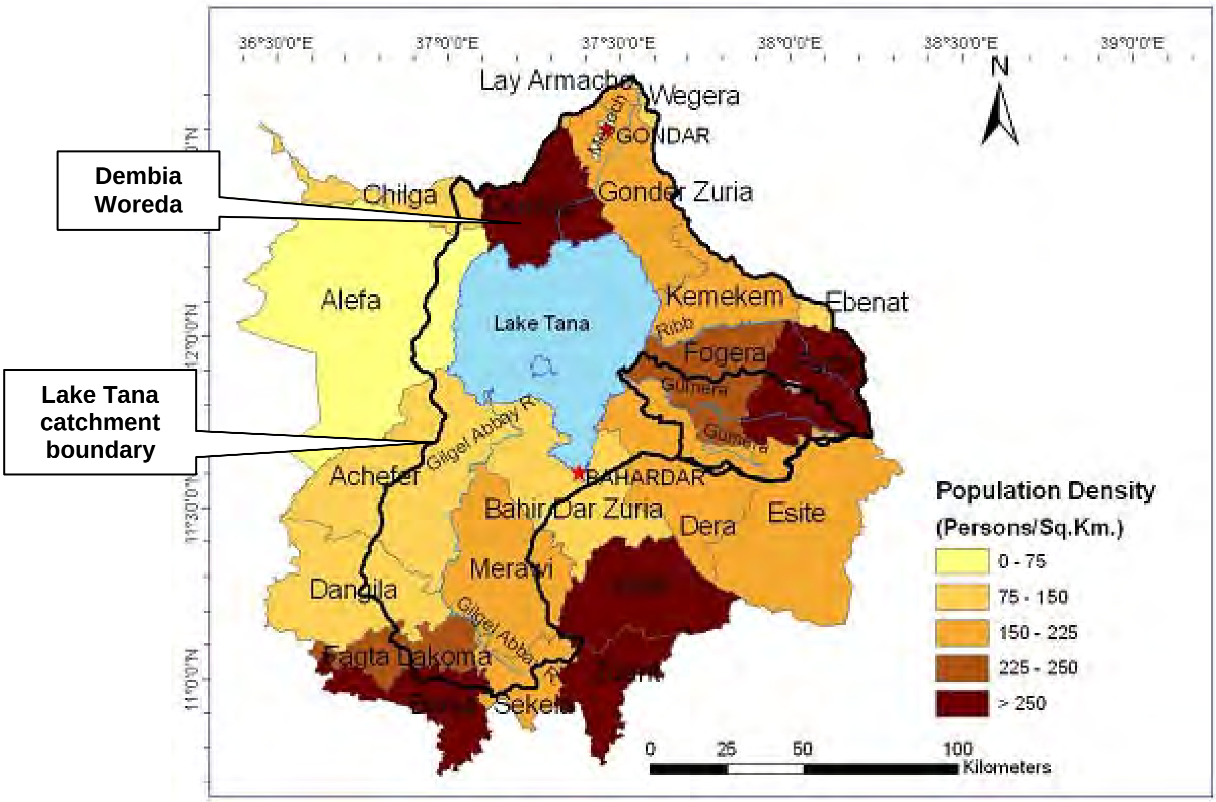
The PCA affects six different kebeles, partly or fully and Map 1, Annex 1.

Table 4-15: Kebeles and Households in PCA (Feb. 2010)

	Kebele	Total number of HH's in Kebele	Part included in PCA (%)	Total number of affected HH's*
1	Seraba-Dabelo	1,579	100	964
2	Achera Mariam	759	100	382
3	Guramba Bata	878	25	232
4	Chenker Cherkose	1,860	10	303
5	Aberjeha Dhena	2,198	25	251
6	Meskel Kiristos	1,132	25	40
	Total	**8,397**		**2,172**

Source: MPIDP RAP (SMEC 2010)

Figure 4-14: Amhara Region Population Density

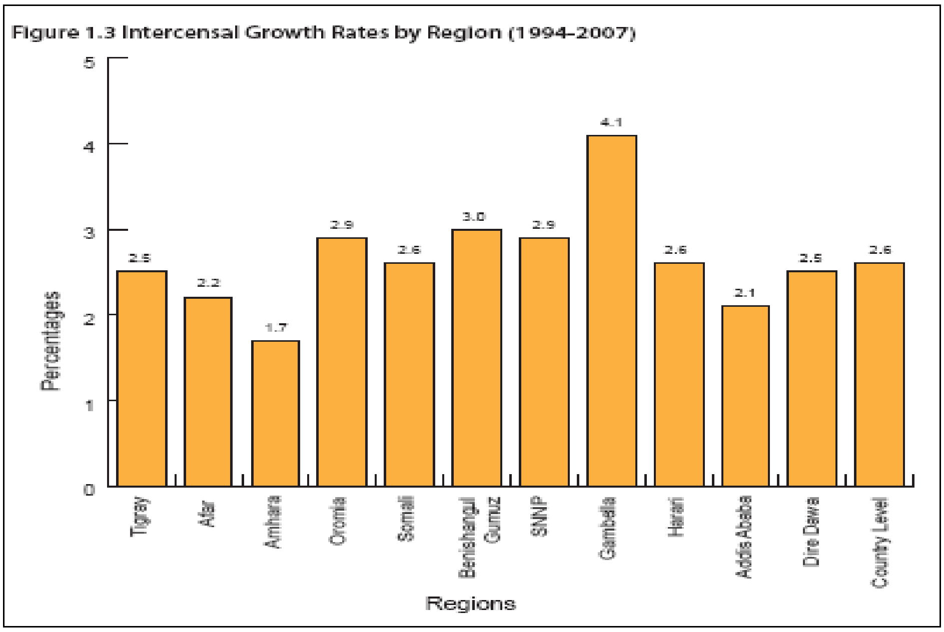


Source: Yilma & Awulachew (2009)

4.4.2.2 Demography

The latest official figures show that Amhara Region has a total population of some 17,113,555 persons, 23.3% of the nation's total. The annual growth rate of Amhara region is now 1.7%, the lowest of Ethiopia and well below the national average of 2.6% (CSA 2008) (Figure 4-15).

Figure 4-15: Amhara Region Population Growth



Source: CSA 2008

The ANRS BoFED, which previously estimated the regional growth rate to be around 2.67%, explains the new lower rate by factors such as a relatively low fertility rate (5.1 children per woman compared with 6 children per woman at the national level), a high infant mortality rate (94/1000 births compared to the national figure of around 75/1000 births), high child mortality (154 deaths for 1000 live births), and low life expectancy (54 years), notably because of AIDS and other communicable diseases.

Dembia Woreda has one of the highest population densities of any woreda in ANRS (

Figure 4-14).

The number of households in the PCA is 2,172 (SMEC 2010), with an average household size of 5.1, giving a total of some 11,179 people or about 4% of the total woreda population.

Applying the regional growth rate to the PCA suggests that an additional 2,052 additional people would have to be accommodated in the area by 2020 (Table 4-16).

Table 4-16: PCA: Projected Population 2020

	2010	2015	2020
Estimated Total Population within PCA (4,000 ha) at constant growth rate (1.7%/yr)	11,179	12,162	13,231

Source: Consultant

Age Structure: MPIDP FS figures indicate that 97% of the population in the PCA is under 50 years old, and almost half the population (46%) is younger than 15 years old. Similar figures are given in the RAP (SMEC 2010). This illustrates that there is a high dependency ratio (persons not working to persons working).

4.4.2.3 Household Size and Population Density

The MPIDP FS (Tahal-CECE 2010) reports an average household size within the PCA of 6, and the RAP a size of 5.1 to 5.5 (SMEC 2010). Some 22% of PCA households are headed by women (SMEC 2010: PAP Census).

The population density of the PCA is 2.1 persons/ha, compared to 2.24 persons/ha for Dembia Woreda as a whole[59].

4.4.3 Infrastructure and Settlements

The main settlements and roads in the project area are shown in Figure 1-2. Dembia Woreda includes three small towns: Kola Diba, the woreda headquarters, population 8,608 (MPIDP FS); Chuahit, population 4,575, and the port of Gorgora, population 2,594. The remainder of the population (91.4%) live in rural areas. The main sub-woreda centres in the Dembia Plain are Guramba, some 2 km north of the PCA on the track to Kola Diba, and Robit, some 4 km to the east of the PCA on the other side of the Old and New Megech Rivers (Figure 1-2). Seraba Dabelo and Achera Mariam are relatively large villages acting as their respective kebele headquarters.

Within the PCA most houses have been built in low-density settlements in locations less liable to flooding, especially along the right bank of the old Megech River channel. The villages tend to be based on extended family and kinship networks and relationships. There is some evidence of clustering near long-established churches, and also near kebele administration offices, presumably to take advantage of available services.

Virtually all houses are built of eucalyptus poles and mud, with earth floors and thatch roofs (Photo 4-21). Government buildings (e.g. health posts, schools, farmer training centres) are similar but usually have metal roofs (Photo 4-27, Photo 4-28).

Access to the PCA is by unmade (earth) tracks from the north or on footpaths from the west. There are no bridges across the PCA rivers (Dirma, Nededit, Kirsit, Megech).

There is no mains electrical supply within the PCA (see Section 4.4.5.8), nor is there any centralised (piped) domestic water system (see Section 4.4.5.9).

There are no warehouses for storage of crops in the PCA, but all kebeles have a Kebele Office and a Cooperative.

The PCA has mobile phone service.

4.4.4 Land Tenure

As noted in Chapter 3, all land in Ethiopia belongs to the State, which does not recognise private ownership of land. Citizens may be granted user rights to land in the form of certificates, and may privately own assets on land such as houses.

The FS socio-economic survey indicates that the average land holding in the command area is 1.07 ha in 6 separate plots. Of this total, typically two-thirds are cropped and the remainder used for grazing (i.e. it is left fallow).

As of mid-2008, 56% of farming households had not received official government guarantee certificates for their land; nevertheless, 96% of the farmers interviewed declared that they "had their own land" (MPIDP FS). Following an intensive campaign, it is understood that First Stage certificates have now been issued to all farming households in the command area (RAP consultant, pers. comm., March 2010). These certificates confirm the holder's rights to use of land allocated in the last major campaign of land redistribution in 2005.

4% of the respondents in the FS socioeconomic survey declared themselves landless.

Lack of land is a major problem for young people, and is perceived to be a major factor in the recent encroachment of cultivation into wetlands, including the lakeshore zone. This has resulted in tensions between residents and the administration, since the regional BoEPLAU is attempting to regulate land use in the lakeshore zone and prevent further encroachment.

One in five farmers rent their land to others, for reasons including lack of oxen for ploughing (50%), lack of labour (41%) and lack of seeds (9%). Typically, rent is paid in kind in the form of 1/3 or 1/4 of the crop (sharecropping).

Land rights are a gender issue: some 22% of the PCA households are headed by women (SMEC 2010), mostly widowed; they often have to rent out their land due to lack of household labour resources to cultivate it. Sometimes this eventually results in permanent loss of the land as dominant males exert control.

[59] PCA: 11,179 people, 5,401 ha (SMEC 2010); Dembia Woreda: 271,000 people, 121,000 ha (CSA 2008).

In addition to land used by households, there are three commercial agricultural enterprises in the area (Wawa, Dembia, Toka) focusing on fruit and vegetable production, and totalling some 305 ha.

Further details of the land tenure situation in the PCA are available in the project's draft Resettlement Action Plan (SMEC 2010).

4.4.5 Livelihoods and the Agricultural System

4.4.5.1 Income

Estimates of average total household income in the PCA vary from ETB 1,088/yr (BoFED 2006) to ETB 4,750/yr (Castalia 2008). The RAP reports that more than half of all household heads in the PCA receive an annual income of ETB 1,200 or less (SMEC 2010). The MPIDP FS reports a weighted annual cash income per household from all sources of ETB 1,116[60], of which 68% is from crops, 19% is from livestock, and the remaining 13% is from petty trade and non-farm activities. This income must be shared between, typically, 5 members of the household, giving the astonishingly low annual per capita income of ETB 223 (~USD 14).

Average annual household expenditure is estimated at ETB 3,506 including the cash value of crops used for home consumption (MPIDP FS). Consequently, as stated in the FS, "… *it is clear that the households in the project area are in deficit, covering only 47% of their expenditures out of their annual revenue*." Since household deficits of this magnitude are not sustainable, it is clear that there must be some errors in these estimates of income and expenditure, perhaps in the methodology used to in calculating the weighted incomes. What is not in doubt is the extreme poverty of the majority of the command area population, and their lack of resources for self-improvement.

4.4.5.2 Cultivation and Crops

Virtually all land in the command area is in use for agriculture, with cultivation extending year by year further into the seasonal wetlands and lakeshore zone (the actual area of cultivation in the PCA is about 3,220 ha (MPIDP FS)). Farming households rely on cereals and pulses for subsistence, with surpluses and some horticultural products being sold for cash. Cattle are an integral part of the system, being required for cultivation, with secondary roles in producing milk, manure (used for fuel), and being a financial asset that can be sold in times of crisis.

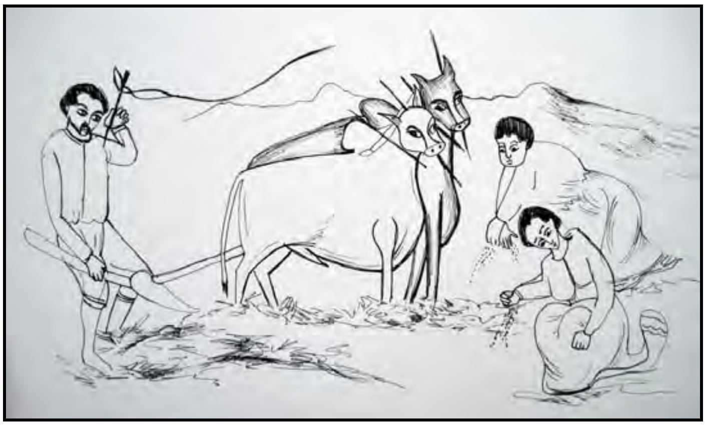
The major cereal crops are teff (*Eragrostis tef*), sorghum, maize, wheat, barley and finger millet, in that order. The most popular pulses are chickpea, faba bean and grass pea. Within the woreda the two most important horticultural crops are potato and pepper. White cumin is the most important spice. Crop production is diversified to minimise risk.

Crops are grown (i) during the rainy season, on land above flood levels (rainfed); (ii) after the rainy season, using residual moisture as floods recede, (iii) during the dry season using irrigation, where available. Because of the dominance of the subsistence cereal crops - especially teff which has a long growing period (see below) - and lack of dry-season water, the cropping intensity in the area is only 1.13 (MPIDP FS).

The main cropping season begins in February and lasts until November or December. A large part of this time, 4-5 months, is for land preparation since the crops are not planted until the onset of the rains in May or June. Cultivation is done using the traditional ox-drawn wooden plough (*maresha:* Figure 4-16). Crops using residual moisture are planted in September for harvesting in December or January. Dry season cropping using irrigation begins after harvesting crops grown on residual moisture, giving planting dates from January to March.

[60] MPIDP FS, pB-84

Figure 4-16: Tillage with Maresha[61]



Some farmers use fertilisers (urea and DAP), but many rely on the natural fertility of the alluvial soils, replenished every year by flood-borne silt.

Pests and diseases are a major problem (Table 4-17), causing significant crop losses both in the field and during storage, which is mainly in traditional woven baskets (*gottera*). Weed control is achieved by hand weeding, although there is some use of herbicides. Further details are given in the Pest Management Plan at Annex 8 of this report.

Table 4-17: Main Crop Pests and Diseases

Pest or Disease	Proportion of Damage (%)
Insects	37
Weeds	26
Storage pests	20
Plant diseases	12
Other (inc. birds, rats etc.)	5

Source: adapted from Table B.1-19, MPIDP Feasibility Study

Detailed descriptions of the crop production system in the area and its constraints and opportunities are available in (i) the MPIDP FS, and (ii) Akalu Teshome *et al.* (2009).

4.4.5.3 Existing Irrigation Practices

Two types of irrigation are carried out in the command area: river diversion, and pumping. Both are small-scale and rely on simple technologies, and both are recent developments: farmers only started dry-season irrigation along the Megech River some four or five years ago.

Small-scale irrigation is carried out wherever water can be diverted by weirs from existing sources and led by gravity to fields, during the dry season. Consequently it is most common along and near rivers such as the Dirma and Megech and their tributaries (Photo 4-11, Photo 4-12). This type of smallholder irrigation is practised on some 3,027 ha within Dembia Woreda (Woreda Agricultural Office), and is common in Chenker Cherkose Kebele.

[61] Original artwork © Aster Abebe.

Photo 4-11: Dhana River, Chenker Cherkose Kebele, March 2010 (dry season)

Photo 4-12: Traditional irrigation by gravity from Dhana River, for onions, March 2010

A new technique is the construction of channels to lead water from the lake into the lakeshore zone (Photo 4-13).

Photo 4-13: Irrigation by leading lake water into lakeshore zone, Achera Mariam Kebele, March 2010

Farmers with additional financial resources and the three local commercial farms (Wawa, Dembia, Toka) use pumps to lift water from rivers in the dry season (Photo 4-14, Photo 4-15, Photo 4-16). In 2007-8 small pump irrigation was practised on about 487 ha in Dembia Woreda.

Photo 4-14: Irrigation by pump from Dirma River; note also domestic water collection by residents

The Woreda has plans to rapidly expand the area under small-scale irrigation, but this is constrained by poor pump quality and limited maintenance capacity.

There is very little development of groundwater for irrigation - in the Dembia plain groundwater is accessed at 6-7 m depth, and the walls of hand-dug wells have a tendency to collapse.

Water distribution is arranged by traditional mechanisms under the control of an elected, unpaid "water father" or "water judge" (*Ye wuha abat*, *Ye huwa degna*), assisted by water distributors (*sirfege*) assigned to every 25 or 30 users. Typically water allocations are scheduled based on the number of association members rather than on crop types or areas. Irrigation intervals vary from 7 to 21 days. Further details are given in Akalu Teshome *et al.* (2009) and in the FS.

In-field irrigation is typically by flooding, although some farmers grow vegetables as row crops.

Where irrigation water is available, farmers are able to fit in two irrigated crops per year, typically October - January, and February to May. The dominant irrigated crops in the PCA are vegetables and root crops, followed by pulses.

Photo 4-15: Commercial irrigation by pump from Dirma River: Wawa Farm, 2009

Photo 4-16: Irrigation by pump from small river in command area, Feb. 2009

4.4.5.4 The Role of Flooding

The floods which affect the command area every year have four important economic roles:

Firstly, they bring fine sediment and associated nutrients from the uplands and deposit these in the floodplain, creating and maintaining fertile soils.

Secondly, they provide moisture which allows recession cropping, especially of Chickpeas (*Cicer arietum*).

Thirdly, they provide water to the seasonal grasslands which are essential components of the livestock husbandry system.

Fourthly, they create large areas of habitat important for spawning and for juvenile fish.

Consequently, although they create major problems of access and health (see below and Annex 7), floods also bring major benefits.

4.4.5.5 Livestock Husbandry

97% of the households in the PCA are reported to own livestock (MPIDP FS). These are an integral part of the farming system in the floodplains and provide around 20% of household incomes. Statistics from the affected kebeles indicate that every household has on average three cattle and at least two chickens, nearly every household has one sheep or goat, and there is one pack animal (typically a donkey) for every five households (SMEC 2010).

Cattle

Cattle are essential as draught animals, harnessed in pairs to the wooden ploughs used for centuries to prepare the land for growing teff and other crops. They are also used in threshing, and provide a variety of other products and services, especially milk, manure, and (as a last resort) acting as saleable assets.

Cattle dominate the livestock of the project area, numbering 33,701 and providing 75% of the livestock biomass (MPIDP FS)[62]. The very high numbers are largely due to the need to maintain a herd of 8 - 16 cattle to ensure the availability of a pair of oxen, which make up some 26% of the cattle population. Oxen work, on average, 90 - 120 days per year. At the end of their working life they are fattened for slaughter.

Cattle breeds are traditional and include some Fogera cattle (a local breed developed by cross-breeding the local Sanga types with Zebu cattle introduced after the great rinderpest epidemic in the 19th Century).

[62] The RAP (SMEC 2010) reports a total of 26,838 cattle in the six affected kebeles. Either way, the numbers are very high.

The major sources of feed are natural pasture (51%) and crop residues (41%), with little or no supplementation or provision of hay and no stall feeding. In the dry season, in daytime cattle, sheep and goats are herded by boys on the seasonally flooded grasslands, which are reserved as communal grazing areas by the respective kebele administrations. At night livestock are returned to the homestead. At the onset of the wet season most cattle are moved to higher ground, outside the boundary of the PCA ("transhumance": Photo 4-17)[63]. This system has many consequences - demands for household labour, especially young boys (Photo 4-18); reciprocal relations with upland farmers; predation of dry-season crops by wandering livestock, etc.

Photo 4-17: Cattle grazing stubble, hills adjacent to command area, March 2010

In general, this traditional system is characterised by low productivity, uncontrolled breeding, late maturity of animals, long calving intervals, and rampant livestock disease (veterinary services are very weak).

Photo 4-18: Herdboys, Megech command area, 2009

The four main technical constraints hindering improvement of the livestock system are seen as (MPIDP FS):

- Limited genetic potential of indigenous livestock.
- Widespread livestock diseases.
- Inadequate feed supplies and poor animal nutrition.
- Poor marketing infrastructure and arrangements.

63 Farmers from Dembia used to trek their livestock to Quara, but this is no longer possible due to local resistance and robbers: Akalu Teshome *et al.* (2009).

Other Livestock

Small numbers of sheep, goats and poultry are owned by most families, and used to supplement household nutrition and for sale. Donkeys provide transport.

Bees and Beekeeping

An important part of the floodplain farming system in the area and elsewhere around Lake Tana is beekeeping. 16,000 hives are reported from Dembia Woreda (Akalu Teshome *et al.* 2009). The majority of hives are traditional (270 out of 288 in Achera Mariam[64]), each producing 4 - 10 kg of honey per year (Photo 4-19). The modern hives produce around 20 kg/yr. Wax is not harvested, and the honey is not processed. The main market appears to be Kola Diba, with prices ranging from ETB 20 - 35/kg, depending on quality. The main use of honey is for *tej*, the traditional fermented honey-based drink. Honeybees provide important pollination services for local crops such as *noug* (Niger seed) (Kerealem Ejigu *et al.* 2009).

Recently beekeeping is reported to have been affected by reductions in bee forage (due to deforestation and overgrazing), floods, ants, birds, wax moth and - very importantly - non-selective pesticides (Akalu Teshome *et al.* 2009).

Photo 4-19: Traditional beehives

4.4.5.6 Fisheries

Fishing is a secondary occupation for PCA residents, typically practised by the most vulnerable and disadvantaged households (Photo 4-20): "*Without fish, my family would have nothing else to eat*" (comment by farmer to social team in Dec. 2008).

Fish not required for subsistence can be sold fresh in the market at Chuahit for ETB 4-5/kg, or if dried for ETB 7/kg. Dried catfish fetches a higher price than dried *Labeobarbus*.

Photo 4-20: Fishing from tributary of Dirma River in Aberjeha Kebele, 2009: Barbus and catfish

In some places in the PCA it is culturally forbidden to eat fish during periods of fasting.

64 According to the kebele Development Agent in March 2010.

4.4.5.7 Other Income Sources

In addition to crops, livestock products, and fishing, other income sources include (i) manufacture of charcoal (Photo 4-22), (ii) collection and sale of combustibles (sticks, manure (Photo 4-21), crop residues), (iii) casual labour and other services (men), (iv) washing clothes and domestic services (women), and (v) brewing. As in all subsistence communities, households tend to live from day to day with few reserves.

4.4.5.8 Energy

Mains electricity reaches Dembia Woreda headquarters, the town of Kola Diba, and Gorgora is reported to have been connected in 2008, but none of the settlements within the PCA are electrified.

In all the PCA kebeles, fuel for cooking and heating comes from three sources, in the following order of importance: dung (dried manure cakes: Photo 4-21), eucalyptus grown in and near settlements (either direct or as charcoal: Photo 4-22), or sticks (from scrub on hillsides) and crop residues. Women are responsible for collecting and processing fuel.

91% of the PCA households (MPIDP FS) or 67% (RAP) report planting trees around their residences, mainly for fuel. These are virtually all eucalyptus (*Eucalyptus camaldulensis*), grown at close spacing and coppiced.

Photo 4-21: Manure cakes for fuel, command area, March 2010

Photo 4-22: Making charcoal from Eucalyptus, command area, 2009

4.4.5.9 Domestic Water Supply and Use

In the PCA most water for domestic uses is obtained from groundwater, although households close to the Lake Tana fetch water from this source, especially if the groundwater is too saline as in parts of Achera Mariam Kebele. Groundwater is obtained from hand-dug wells (*gulgad*) which are generally unprotected and easily contaminated (Photo 4-23). Groundwater can be found at 8-14 m depth in the dry season.

Based on information from the Woreda water resource development office, there are about 130 drinking water hand-dug wells in the Megech plains. In some locations shallow hand pumps have been installed (Photo 4-24).

Photo 4-23: Typical unprotected well in command area, 2009

In parts of Aberjeha and Chenker Cherkose Kebeles water is obtained from the bed of dried-up rivers (Photo 4-25).

Drinking water is obtained from the cleanest available source, usually groundwater, whilst water for laundry is taken from rivers when they are flowing. Supplying domestic water is exclusively a female task. If lucky, households have a well or can use a neighbour's well. If not, there are some kebele wells, typically within 10 - 30 minutes walk[65]. If the groundwater is too saline, the wells are too far or inaccessible for socio-cultural reasons, women must walk for up to 2 hours one-way to Lake Tana to fetch water.

Photo 4-24: Hand pump at Guramba, 2009

65 5 in Seraba, 4 in Achera and 5 in Guramba: RAP Consultant, 2010.

Photo 4-25: Collecting water from bed of Gilgel River, Chenker Cherkose Kebele, 2009

Domestic water consumption appears to be around 20 l/pers/day, but this varies considerably according to access and may include water for livestock. Women in Seraba Dabelo informed the study team that sometimes there is not enough water for drinking. Hygiene is a casualty of lack of access to water: women in Guramba reported washing themselves once a month in the dry-season, and in Achera Mariam once every 3 months or before delivering a baby.

In the dry season livestock are watered from hand-dug wells such as that shown in Photo 4-23.

4.4.6 Social Indicators

4.4.6.1 Education

Three out of four residents of the households in the project command area have no formal education, rising to 87% of household heads (SMEC 2010). The FS social survey reports that 76% of household members have Grade 1 education or less, and only 10.6% of household members have completed primary education (Grades 1 to 6 or higher). Functional illiteracy is widespread - a figure of 68% of residents older than age 18 is given in the RAP. Gendered educational data are available from the Woreda office of finance and economic development; these indicate literacy rates of 23.4% amongst males and 20.2% amongst females in the six PCA kebeles (SMEC 2010).

"Primary cycle" or Elementary schools (Grades 1 to 4) are present in all project kebeles and "Full cycle" (Grades 1 to 8) in Seraba Dabelo and Aberjeha (some 50-55 minutes walk each way, on average). The condition of these facilities is primitive, with no desks, water, latrines or electricity (Photo 4-26, Photo 4-27). For education beyond Grade 8, students must travel to the woreda headquarters at Kola Diba or to Gorgora. For most PCA students, this is not feasible on a daily basis.

Photo 4-26: Guramba Elementary School (Grades 1-4), March 2010

Photo 4-27: Seraba Dabelo "Full Cycle" School (Grades 1-8), March 2010

Since most household heads are illiterate and there are few formal employment opportunities requiring school education, there is significant pressure on children to leave school early to work on the family farm, to generate alternative income (e.g. from sand-mining in dry river beds), or (especially for girls) for marriage.

There are no kindergartens in the PCA, so children below school age require continuous supervision at home.

4.4.6.2 Health

The main health hazards in the PCA are vector-borne tropical diseases especially malaria, intestinal schistosomiasis and soil-related intestinal helminths. At this Latitude, the elevation of 1800 m asl is compatible with the cycles of transmission of all these diseases, and they are widely observed in the population. They are the principal diagnosis made in the health facilities, and the origin of the major part of the drug prescriptions.

The lack of permanent roads inside the PCA is of importance for health. During the rainy season and the beginning of the dry season - at least during six months each year - the only way to travel within the command areas is on foot (or by donkey) or by boat. Professional health workers are rarely present inside the command areas, largely due to difficult access, and it is difficult for patients to physically access health care.

The top ten diseases reported in Dembia Woreda in 2008-2009 are listed in Table 4-18. A full description of the health situation is given in Annex 7, Rapid Health Appraisal. The following text summarises the position concerning vector-borne diseases, waterborne diseases, other health issues, and health services.

Table 4-18: Top Ten Diseases in Dembia Woreda, 2008-2009

No.	Disease	No. of Cases	%
1	Malaria	15,359	40
2	Intestinal parasites	4,902	13
3	Gastritis	3,513	9
4	Other helminthiasis	2,924	8
5	Unspecified nematodes	2,700	7
6	Diarrhoea	2,659	7
7	Acute respiratory tract infections	2,354	6
8	Skin infections	1,410	4
9	Rheumatism	1,272	3
10	Tonsilitis	1,089	3
	Total	**38,182**	

Source: Dembia WorHO

- **Vector-borne and Soil-related Diseases**

Malaria: according to the ANRS Bureau of Health (BoH) annual report (as reported in Alemayehu 2008), 80% of the land of the State is malarial and 75% of the population is at risk of malaria infection. Malaria is responsible for 15-40% of hospital admissions, 7-30% of hospital deaths, and has a 10-25% case fatality rate.

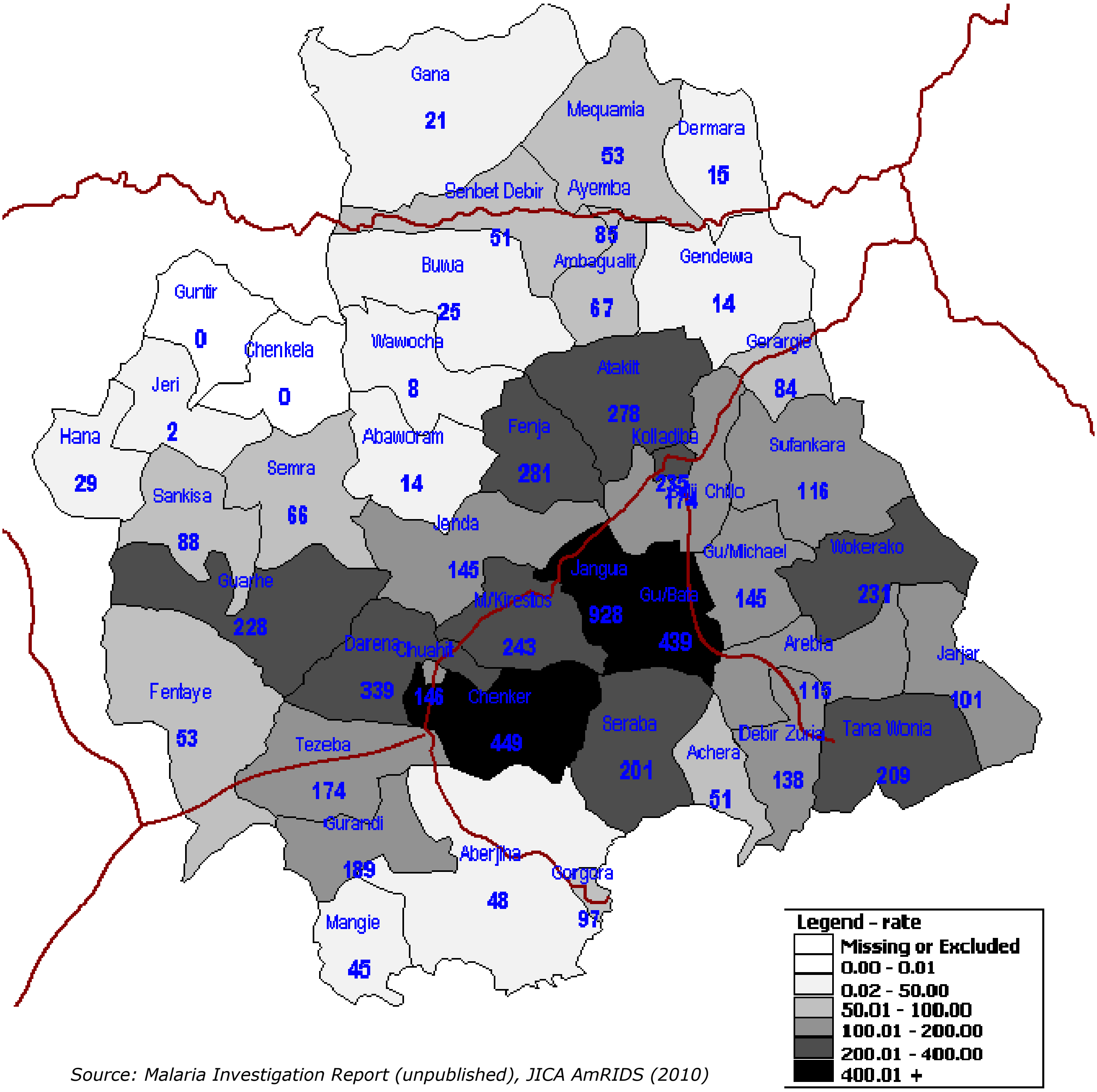
Malaria is the leading public health concern in the Megech area. It is present all the year round with a peak of attacks at the beginning of the dry season, from September to December (Figure 4-17). Incidence rates in and near the Megech project kebeles varied from 2% to over 9% in September 2002 (see Annex 7). Women report malaria to be the principal threat to babies.

The situation is classically described as hypoendemic malaria as a result of stable transmission at a low level. The more obvious aspect of this situation is the lack or weakness of acquired immunity against the *Plasmodium* in adults, and the observation of malaria attacks in individuals of all ages.

Plasmodium falciparum is the predominant species, responsible for about 60% of infections. *P. vivax* is the other *Plasmodium* present. The main vector, the mosquito *Anopheles arabiensis*, belongs to the complex *Anopheles gambiae* sensu lato. *An. gambiae* sl are various species of highly efficient malaria vectors. At the peak of transmission, the rate of infected females can be up 1%. These mosquitoes breed in puddles on the lake shoreline, pools of rainwater, and man-made pools of shallow, sunny and clean water.

The malaria transmission pattern changes to an epidemic once every 5 to 7 years, with a sudden peak in incidence. The reason for this well-described, episodic situation is probably the development of a larger than usual population of *Anopheles* mosquitoes due to a longer than usual rainy season, together with the receptiveness of human beings to the disease as a consequence of levels of transmission usually being lower.

Figure 4-17: Malaria incidence per 10,000 in Dembia Woreda by Kebele, 1-30 Sept. 2002



Source: Malaria Investigation Report (unpublished), JICA AmRIDS (2010)

The present malaria control and prevention policy of Ethiopia comprises (i) vector control through indoor residual spraying with pesticides, (ii) long-lasting bed net distribution, and (iii) case management (chemotherapy). Chloroquine is used for the treatment of *P. vivax* attacks. For the last several years *P. falciparum* attacks have been treated with an Artemisinin Combined Therapy (ACT) after, if possible, a laboratory diagnosis (microscopic examination of thick blood film or Rapid Diagnostic Test (RDT)). The ACT is Coartem®, a highly effective combination of artemisinin and lumefantrine. The RDT is the Paracheck® test which can confirm the presence of *P. falciparum* but not of other malarial parasites; these require microscopy by experienced technicians.

In the public health centres and posts, at present RDT and malaria treatment are free of cost. However, the microscopic observations are not free (ETB 3 per sample). The choice between the two tests, microscope or RDT, depends on what is available in the particular health facility, and also on the clinical impression of the health workers. In case of a suspected *P. vivax* infection, microscopic examination is systematically used, if it is available. A large proportion of the treatments given are presumptive (based on observed symptoms, not on lab. diagnosis). The fact that treatment is free may be a cause of excessive demand.

The Ethiopian National Malaria Programme promotes the use of Long Lasting Insecticidal Nets (LLINS) to reduce contact between human beings and *Anopheles* mosquitoes. A large free distribution of LLINS has been done since 2005 in all the country including the surroundings of Lake Tana. Health workers are responsible for educating local residents as to their purpose and for promoting correct use. However, bednets appear to be used by few of the residents of the two command areas. Interviews with outpatients at Yifag Health Centre (Ribb area) suggested that the bednets are worn out since they have been used for four years without replacement; the inhabitants expect replacement of bednets at least every two years. Despite the average numbers of bednets per household being reported as 1.9 in the Megech command area, their number is not sufficient for use by each individual (typical household sizes is 6 persons). Moreover, the use of bednets is never easy in a poor household without standard beds and mattresses and with the frequent presence of smoke inside the houses. It is also possible that part of the population does not accept that bednets will reduce the chances of contracting malaria; the appraisal team observed bednets being used for non-intended purposes such as infant slings and wrapping goods.

In summary, malaria is a major problem all the year round for individuals of all ages living in the Dembia plains. Its incidence shows an annual increase from September to December, and periodically malaria outbreaks as a local epidemic.

Intestinal Schistosomiasis: intestinal schistosomiasis or bilharziasis (*Schistosoma mansoni* infection) is present around Lake Tana, as elsewhere throughout much of the country. In Ethiopia most transmission sites are between 1300 and 2000 masl. Some ponds, puddles and the lake shoreline are infested with *Biomphalaria pfeifferi*, the parasite's major intermediate host. These snails are not present in rapidly flowing streams or rivers. Various recent studies carried out in the surroundings of Lake Tana have evidenced prevalence rates of intestinal schistosomiasis of 20% to 50% of children attending schools. These infections are most often light or moderate.

Cases of intestinal schistosomiasis are diagnosed in the Health Centres in the Megech area. These diagnoses are done clinically in some Health Centres and with confirmation by microscopic examination of stool samples in other Centres, according to the equipment available and capacity of the staff. Since the symptoms of moderate infections of *S. mansoni* are similar to those of intestinal helminth infections or of repetitive diarrhoeas, it is probable that the prevalence of intestinal schistosomiasis in the local populations is underestimated. This can be confirmed by specialised surveys (stool analysis of representative samples of the population), which should be carried out prior to commissioning of the two irrigation schemes.

Urinary Schistosomiasis: in Ethiopia, *Schistosoma haematobium* infections (urinary schistosomiasis) are confined to lowlands below 800 masl in the western part of the country and in the low Awash Valley (Central Ethiopia). The rareness of the foci is largely due to the non-susceptibility of most bulinine snails to the Ethiopian strain of the parasite, and maybe also to the relatively low water temperatures in the Highlands. However, the snail host/parasite relationships and the dynamics of the snail populations are not easy to predict.

According to available literature and discussions with local health staff, at present urinary schistosomiasis is not observed around Lake Tana. However, the water-related environmental changes which will be caused by the projects, especially the construction of many 100 km of secondary and tertiary canals and drains in each irrigation scheme, could result in new biotopes (habitat) favourable to *Bulinus* snails. If this occurs, and if *S. haematobium* is introduced to the area by infected people from the Lowlands, the disease could emerge around the lake. Consequently, as for intestinal schistosomiasis, a specialised survey prior to commissioning of the scheme is recommended.

Soil-related Intestinal Helminths: according to various published surveys, intestinal soil-transmitted helminths ("worms", including for example *Ascaris*, *Trichuris*, hookworms) infect a large part of the population living around Lake Tana. Considering the low level of sanitation, especially the small number of households with latrines and effective use of them, the high prevalence of intestinal helminths infections is not surprising. Most residents defecate in fields. Human faeces are present in some places near homesteads and also in cultivated plots. These open deposits allow the continuation of the parasites' lifecycles from human intestinal tracts onto the wet soils and plants. Human infestations result from ingestion of the larvae on contaminated food or, for hookworms, through the skin of the feet and legs of farm workers and children.

Intestinal helminthic infections are one of the most frequent diagnoses done in the health facilities of the two project areas. The diagnoses are usually done by clinical examination only; stool examinations cannot be done in all health facilities. It is possible that some abdominal pains or weakness due to other causes are explained as intestinal helminthic infections. Some confusion with intestinal schistosomiasis can also appear, including the fact that these various infections can be present in the same individual at the same time, with similar symptoms.

Other Vector-Borne Diseases: (i) Visceral Leishmaniasis (Kala Azar) is present around Lake Tana. The sandfly vector prefers dry environments, and is present in the hills adjacent to the command area. A few cases have been reported from the Woreda. (ii) Dracunculiasis (guinea worm) is not reported at present. (iii) Yellow fever requires *Aedes* mosquitoes for transmission. No cases have been reported in highland Ethiopia since 1966. (iv) Dengue, also transmitted by *Aedes* species, is not reported from around Lake Tana at present. (v) Human African trypanosomiasis (sleeping sickness) is endemic at lower elevations in Ethiopia but not in the highlands due to the absence of tsetse flies (although the animal version, spread by biting flies of the genus *Stomoxys*, is common around the lake). (vi) Onchocerciasis (river blindness) is not reported from the Lake Tana area but is found at lower elevations in ANRS.

- **Waterborne Diseases**

Note: most "waterborne diseases" result from inadequate access to safe water for drinking and washing. They are commonly spread by flies, dirty hands etc. rather than by dirty water.

Diarrhoeas: according to information from the Woreda Health Office, and as confirmed by households during the household survey[66], diarrhoea stands second or third among the most important health problems in the project area, after malaria and intestinal parasites. The number of cases is probably higher than reported because everywhere in the world diarrhoeas are often treated at home by traditionally practices, or neglected. Neglected diarrhoeas are one of the main causes of infant deaths in poor countries. Acute watery diarrhoea (AWD)[67] is present in the woreda.

Amhara BoH is distributing a water treatment chemical (chlorine: named "Agar®") to some villages in areas with limited access to safe drinking water.

Poliomyelitis: human infection by the poliomyelitis virus ("polio") results from drinking contaminated water. Worldwide mass vaccinations against the disease have resulted in near-extinction of the virus, and Ethiopia was poliomyelitis-free for four years until December 2004. Then, some cases in infants and children were reported in three regions, including ANRS. Risk factors that may have facilitated spread of the outbreak include gaps in vaccination coverage, interruption of the cold chain system, gaps in surveillance performance, high population mobility, poor environmental sanitation, crowded living conditions and unsafe drinking water. House-to-house investigation and vaccination campaigns resulted in a new interruption of transmission.

According to local health professionals, no cases of poliomyelitis have been reported in the Megech area.

66 The survey was carried out by the project design consultant in 2008.

67 In Ethiopia cholera is generally termed AWD.

- **Other Diseases and Health Issues**

Trachoma: trachoma, a chronic eye infection by *Chlamydia* bacteria, is hyperendemic in a large part of Ethiopia including the rural areas around the Lake Tana. The 2006 national blindness and low vision survey (Yemane *et al.* 2006) suggests that Ethiopia is the most trachoma-affected country in the world (Emerson *et al.* 2008). Various clinical aspects of the infection can be observed in up to 90% of the children and adults in the rural areas of the country. Amhara National Regional State is disproportionately affected by trachoma, bearing an estimated 45% of the national trichiasis burden and with approximately 1 in 20 adults suffering from trichiasis (Berhane *et al.* 2006), and with some 645,000 persons requiring corrective trichiasis surgery in the State (Emerson *et al.* 2008).

The disease is associated with the presence of flies, which transmit *Chlamydia* from one individual to another. The lack of hygiene, of clean water, of soap for washing the face, and contact with dust, especially in houses with mud floors and wattle and daub walls[68], all contribute to the transmission and development of the disease. Trachoma is not a result of an excess of water or of a wet environment; it is linked to a lack of hygiene, to poverty and to frequent contact with flies.

Trachoma control is through the SAFE strategy (Surgery, Antibiotics, Facial cleanliness and Environmental improvement (water and sanitation)). This strategy includes the construction and use of low-cost latrines, after community mobilisation. The Federal Ministry of Health aims to eliminate the worst form of the disease, blinding trachoma, in Amhara State by 2012. The ANRS BoH is planning an integrated malaria and trachoma control programme, with assistance from the Carter Centre.

Acute Respiratory Tract Infections: in and near the irrigation scheme, acute respiratory tract infections (ARTI), including bronchitis and pneumonia, rank among the top three causes of morbidity together with malaria and diarrhoea. Low temperatures, especially during the night, the poor housing conditions, the indoor fires of cow dung and wood without evacuation of the smoke are cumulative elements contributing to a high incidence of ARTI. In infants and children, repetitive ARTI can lead to malnutrition through repetitive fever attacks and exhaustion. Without efficient treatment, ARTI is one of the main causes of death of all age groups.

In the project area, diagnoses of ARTI are made by clinical examination. Treatments - antibiotics and cough mixtures - can be bought at the health facilities or drug shops. However, despite the use of generic drugs, they can be expensive in relation to the low incomes of the population.

Tuberculosis: persistent respiratory symptoms may be indicative of pulmonary tuberculosis ("TB"). The study team was informed that diagnoses cannot be made in the outlying health facilities; suspected TB patients are sent to regional hospitals for diagnosis and treatment in accordance with protocols recommended by MoH's National TB Programme. For this reason, tuberculosis cases are not reported by the Woreda-level health facilities around Lake Tana (Note: as of late 2010 the BoH considers this situation to have changed). According to the medical literature (Getahun & Argaw 2001), the disease is present in South Gonder region with a prevalence of around 1%. At national level the prevalence is about 579/100,000, or about 0.6% (Yimer *et al.* 2005). A national TB prevalence survey is planned for 2010. This should clarify the TB situation in the Lake Tana region, and also cast light on the role played by HIV infection.

As in other parts of the world, TB patients are often ostracised. The sick are ashamed of the possible diagnosis. The time between the beginnings of the symptoms and visiting a health facility can be long, with delays of many months before hospital treatment is provided. Apparent clinical improvement after the intensive phase is sometimes a reason for defaulting on courses of treatment. All these elements, together with the high level of HIV/AIDS, contribute to the importance and perpetuation of the disease.

Hepatitis A and E: various studies in Ethiopia show that hepatitis A infection is widespread and prevalence can be high (Edemariam Tsega *et al.* 1990, Aseffa 1993). The infection starts early in life. Antibodies (anti-HAV) can be found in 50% of the population before 5 years of age, increasing rapidly with age and becoming universal after the age of 15. Socioeconomic factors play a major role in its transmission. No clinical data on hepatitis were included in available WorHO reports in the project area.

68 Wattle and daub: sticks and mud.

Sexually-transmitted Infections, including HIV/AIDS: Ethiopia is amongst those countries where sexually transmitted infections and diseases (STIs, STDs) are highly prevalent. However, information on the seroprevalence rates of STIs, except for HIV infection, is scarce. Modelled data suggest a rise in prevalence of HIV in rural areas of Ethiopia (2003: 2.6% of all individuals) and in all the country (2003: 4.4%), but a stable or declining prevalence from much higher levels in the urban areas (Addis Ababa, 2003: 14.6%) (MoH 2003). Deaths due to AIDS brought life expectancy down from 53 to 46 in 2001 (MoH 2004). Transmission is largely heterosexual (87%), with about 10% mother to child and some evidence of involvement of sharp instruments (MoH 2004) (e.g. for tattooing, circumcision, tonsillectomy, especially in rural areas).

According to the National AIDS Surveillance reports, HIV infection prevalence is 2.3% in North Gonder Zone. However, in 1995 rates of 23·4% and 15·1% of HIV seropositivity among antenatal clinic attenders and rural women respectively were reported, and considered to be an indicator of the rapid progression of the HIV epidemic in the area (Aseffa *et al* 1998). A more recent survey in Gonder (Kassu *et al* 2004) has shown a seroprevalence of 9% of HIV infection in antenatal clinic attendees, and 2% for *Treponema pallidum*, the agent of syphilis but also of non-sexual infections.

For women, syphilis and genital chlamydial infection are associated with young age of first marriage, a low gravidity rate, and the number of husbands. The usual association with HIV infection is observed.

In the Megech area, the health staff of Chuahit Health Centre informed the ESIA's health team about a "high HIV prevalence between 2007 and 2008", but could not provide any supporting statistics. A survey carried out in Dembia Woreda in 2009 found an HIV/AIDs prevalence rate of 1% in the 21,456 people voluntarily tested (SMEC 2010).

Zoonoses: rabies is endemic, as is bovine TB; brucellosis is probably present, but there is no diagnostic capability; the elevation is too high for African Rift Valley fever; and the local health authorities are on watch for avian flu.

Malnutrition: according to various surveys carried out in South Gonder region, the overall malnutrition rate of preschool and school children near Lake Tana is high (Amsalu & Asnaku 2006; Yusuf 2000). The prevalence rates of underweight, stunting and wasting are between 30% and 50%. The weight for age and the weight for height indices are especially low. These data are evidence of chronic malnutrition (stunting). Other surveys (Belachew& Nekatibeb 2007; Worku *et al.* 2009) show a decrease of this chronic malnutrition but not of acute malnutrition. As is usually observed in developing regions, there is a high mortality rate among severely malnourished patients despite hospital admission for therapeutic feeding.

Not surprisingly, income appears the most important factor in determining nutritional status. The amount of land available to each farming family is critical in terms of income levels. Productivity is also important, and can increase with changes in farming practice. Further important factors are the knowledge of parents on how to prepare food and feed their children, and the allocation of a budget for food.

Accidents: no information on agriculturally-related accidents was obtained.

Pesticide Poisoning: no information on pesticide poisoning (either through occupational or accidental exposure, or intentional (suicide / murder)) was obtained. Local health facilities are not trained or equipped to diagnose pesticide poisoning. The BoH expressed concern about the rapidly increasing use of pesticides in the floriculture industry near Bahir Dar, with associated risks to (especially) pregnant women workers and to the local aquifer, which is used to supply drinking water.

Water chemistry: the ESIA's health study team did not obtain any evidence that local residents are being affected by toxic elements in water, such as arsenic.

- **Health Facilities**

Organisation: Health Centres are the focus facilities for curative and preventive health care in rural areas in Ethiopia. Each Centre is designed to meet the medical and health needs of a population of some 25,000 people. They are staffed by a Public Health Officer (4 years college training), nurses (midwives, community nurses and clinical nurses), environmental health workers and other paramedical staff. The role of the Health Centres is mainly related to public health, with some curative interventions.

Health Centres are linked downwards to (typically) five satellite Health Posts which work in conjunction with the Centre, and have a referral relationship to it for more serious and complicated treatment or needs. Each Health Post services some 5,000 persons. Health Posts are run by Health Extension Workers recruited locally, with basic health training. The main functions of the Health Post are "distribution of malarial control and contraception needs, treating and clearing malarious areas, treatment of minor ailments and referring people to the Health Centre for further treatment and vaccination programmes". Those in the command area are of very simple construction (Photo 4-28).

A number of agencies are assisting with health care in the woreda, including the Ethiopian Red Cross, the Amhara Rehabilitation and Development Agency (ORDA), World Vision, and JICA.

Photo 4-28: Health Post, Seraba Dabelo Kebele, March 2010

Health facilities in and near the command area are listed in Table 4-19.

Table 4-19: Health Facilities in and near Project Area

Name	Location
Health Centres	
Kola Diba	9 km north of command area, 2 to 3 hours walk
Chuahit	5.5 km northwest of command area
Aberjeha (under construction)	5 km west of command area
Gorgora	4 km south of command area, 1 to 2 hours walk
Robit	4 km east of command area, 1 to 2 hours walk
Health Posts	
Guramba Bata (possibly under upgrade to Health Centre)	2.5 km north of command area
Achera Mariam	Inside command area
Seraba Dabelo	Inside command area
Chenker Cherkose	West of command area
All other Kebele centres	

Source: Dembia Woreda Health Office and ESIA field survey

4.4.6.3 Gender Differentiation

ESIA team focus group discussions with women (Photo 1-2) and the findings of the FS and RAP socioeconomic surveys confirm that women in the PCA suffer from the same male-dominated cultural traditions and behaviour as elsewhere in Ethiopia: they work longer hours but have less power over their lives and resources than men, and are excluded from virtually all decision-making (as stated by 97% of respondent households in the FS socio-economic survey).

Nevertheless, all women interviewed by the ESIA social team reported open sharing of household incomes. This is surprising, running counter to typical perceptions of household dynamics and the overwhelmingly male-dominated social system in which women are marginalised. It is possible that in many households the income from cropping activities, an exclusively male task representing around 80% of total annual incomes, is retained and spent by men, while women are able to generate additional income via secondary sources such as butter, handicrafts, brewing, etc.

Tasks reserved exclusively for women include fetching water, collecting fuelwood or other combustibles, child-rearing, preparing food and other housekeeping chores, and caring for the sick and elderly. In addition women may sometimes work in the fields, planting, weeding, harvesting and threshing, although these are generally male tasks. Men cultivate the fields, harvest teff, make bulk crop sales, buy tools and inputs, and interact with outsiders.

Traditionally, livestock husbandry (cattle) is mostly a male task (especially ploughing with oxen, herding, buying and selling) although women may sometimes assist with milking, collecting crop residues and forage. Field surveys indicate that women are now more heavily involved with livestock than previously, especially with smallstock (sheep and goats) but also cattle. Women are not usually involved in beekeeping or fishing.

Overall, women work 14 hours per day compared to men's 12 hours (MPIDP FS).

Female-headed households make up about 20% of the PCA total. There is significant anecdotal evidence that these households are susceptible to loss of land since single women do not have sufficient time, resources, skills or access to influential figures to take their cases to the administration. It is extremely difficult for divorced, widowed or separated women to maintain their rights to land, over the long term.

Early marriage, sometimes by abduction, "harmful traditional practices" (HTP) and fear of childbirth are still important features of life for women in the PCA.

4.4.6.4 Incomes & Poverty

As noted in Section 4.4.5.1, weighted average annual household incomes in the PCA are reported to be around ETB 1,116, whilst expenditures are ETB 3,506 in cash or foregone crop sales used for home consumption (MPIDP FS). This puts the population of the PCA far below local and international poverty levels: the Extreme Poverty Line established at national level is ETB 806 per adult per year, at 1995/96 average prices (MoFED 2006)[69].

4.4.7 Social Capital

4.4.7.1 Social Organisation

Self-assessment by farmers resulted in the following list of local organisations, in order of their importance in providing services to the community (Akalu Teshome *et al.* (2009)):

- (i) the Church, (ii) the Agricultural Development Office at kebele level, (iii) the Health Post, (iv) the school, (v) farmers' cooperatives, (vi) the local administration, (vii) the Animal Health Post, and (viii) water users' associations (traditional).

This analysis highlights the Church as the dominant institution in the area, with a role extending into many if not most aspects of PCA residents' lives (see Section 4.4.10). Respondents did not mention the traditional community groups of *Iqub* or *Idir* (see next Section), probably because of the specific questions asked.

Elders and religious leaders are crucial to maintaining order at community level since they are active in promoting social norms and are the final and only arbiters in most disputes.

Various types of traditional working groups exist in the area, and are mobilised to assist agricultural production. These include festive labour (*debo*), *amicha* and other types of friendship-based festive labour, reciprocal labour (*wonfel*), supportive labour for the weak in the early hours of the morning, and full-time supportive labour for the disabled or needy.

69 Table 2.3 in the PASDEP (MoFED 2006).

4.4.7.2 Traditional Savings Systems

Most Amhara communities operate traditional savings systems. In the PCA some 24% of residents are reported to be members of one of these systems (such as *Iqub*, *Idir* or *Mahiber*). *Mahiber* members take it in turns to fund the celebration of a saint's day, usually once every month.

4.4.8 Vulnerable Groups

The social survey and subsequent analysis indicates that the following groups are particularly vulnerable, i.e. at greater risk of further impoverishment as a result of project-induced changes due to lack or resources, social exclusion, disability, inability to adapt, etc:

- Widowed women / female-headed households (22% of all affected households according to the RAP census (SMEC 2010)).
- Households with non-productive members due to disability or age.
- Households with limited assets (land, livestock) and/or limited access to alternative income sources (the majority).
- Households with poor quality land (locally, three grades of land are recognised, and most households have plots reflecting this range of fertility).
- Households with many members, not matched by landholdings (the typical family size is between 5 and 6, but some households are larger).

For the purposes of the RAP, the following four criteria were adopted to define vulnerable households (SMEC 2010):

- Women believed to dependent on others for support.
- Persons over the age of 65 who are unable to support themselves.
- The chronically ill (specifically, confined to bed).
- People diagnosed with HIV/AIDS.

Using these criteria, for planning the project's RAP the six concerned Kebele administrations classified all the households on the official list of households affected by land loss due to construction of the project (Table 4-20).

Table 4-20: Vulnerable Households affected by Land Loss, by Kebele

Kebele	Total No. of Households Affected by Land Loss	Vulnerable Households (No.)	Percent
Seraba Dabelo	1,001	94	9.4
Achera Mariam	389	114	29.3
Guramba Bata	232	79	34.1
Aberjeha	246	61	24.8
Chenker Cherkose	207	58	28.0
Meskel Kiristos	41	6	14.6
Total	**2,216**	**412**	**-**

Source: SMEC (2010)

This exercise resulted in the identification of 412 vulnerable households out of the total number of households affected by land loss (2,216)[70], i.e. 19%.

70 This number (2,216) exceeds the total number of households stated to be resident within the PCA (2,172: SMEC 2010). The discrepancy can be explained if some affected households live outside the PCA.

It should be noted that this total (412) does not include (i) vulnerable households affected by land redistribution and consolidation, or (ii) landless households. These households remain to be identified. It is expected that since nearly all the command area households are affected by both land loss *and* land redistribution, the total of 412 will change little if vulnerable households affected by land redistribution are added. The number of landless households in the PCA is estimated at 4% (MPIDP FS), i.e. 87 in total (4% of 2,172), so on this basis the total number of vulnerable households in the command area is probably about 500. However, the percentage of landless households determined by the MPIDP FS socioeconomic survey is very low compared to the figures determined for two kebeles in the very similar Robit irrigation scheme east of the Megech River: 15% to 25% (Halcrow-GIRD). On this basis the total number of vulnerable households in the command area, and affected by the project, would be closer to 1,000.

4.4.9 People's Perception of the Project

The project preparation consultants (design consultant, ESIA consultant, RAP consultant) have received feedback from project area residents on a number of occasions and by various methods, ranging from informal meetings in the field through focus-group discussions to formal consultative workshops. Although the residents are generally supportive of any project or changes that will lead to economic betterment and increased livelihood opportunities, especially roads and marketing facilities, they are, overwhelmingly, concerned about **land**.

Land is fundamental to survival and a "gift from God". Arable land is the main basis for livelihoods, as it has been in this location for several thousand years. Locally, farmers recognise three different levels of soil fertility, *warsa*, *aygebere* and *dagusa ses* from high to low, respectively. The 1990s land reform and subsequent 2005 redistribution attempted to share out land of these three perceived fertility levels equitably, and the results appear to be generally accepted. Farmers are fearful that the project could result in either an absolute loss of land, or loss of access to a fertile plot due to land redistribution and consolidation.

Other major concerns amongst farmers relate to:

- Most importantly: loss of assets and inadequate or no compensation (based on memories of the traumatising DERG villagisation programme, local experience of uncompensated displacement for Wawa Horticultural Farm and for the *kuam* project (a privately run 120 ha irrigation scheme between the Dirma and Kirsit Rivers), and the complaints of people displaced by the Koga project and, more recently, by the Ribb dam).
- Displacement to make way for commercial farms or "investors".
- Having to change cropping patterns and systems, especially (i) a reduction in crop diversity and therefore an increase in risk, and (ii) not having access to the cereals essential for the traditional staple diet (*injera* made from teff or sorghum).
- Loss of communal grazing lands (especially important for women because of their dependence on livestock) and trees.
- Inadequate markets.
- Ability to pay the future water fees.
- Soil exhaustion due to intensive cropping and fewer floods, and the need to pay for inputs such as fertilisers.
- A possible rise in taxes.
- Price drops due to over-production and inadequate markets.
- The need for draught power for cultivating year-round.
- Potential impacts on burial grounds.
- Health impacts - HIV/AIDS hazards especially for young women, more malaria.
- Sexual assaults on women by construction workers.

According to the MPIDP FS and RAP, women's expectations of the project focus on increased incomes from homestead vegetable gardens and other microenterprises. Women are more attached to their houses and more concerned about adapting and resettling than men, probably because they fear disruption of the known systems women use to provide for families on a daily basis (where the water is, reciprocal relations with neighbours, etc). There is also an undercurrent of hope - currently the situation for women is very difficult and morale is low, but perhaps the project will bring positive changes.

4.4.10 Cultural Heritage

4.4.10.1 Living or Intangible Cultural Heritage

The project area has an extremely strong intangible cultural heritage expressed in religious beliefs, songs and dances, and cultural practices and attitudes[71]. The dominant force is the Ethiopian Orthodox Church. This practices a unique form of Christianity based on the introduction of the Syrian doctrine to Ethiopia by Frumentius in the 4th Century AD. Outward aspects of this religion include strict religious observances, frequent church attendance, extensive fasting, numerous holy days (Table 4-21), and festivals such as *Timkät*, Epiphany and Easter. The clergy are highly respected as authority figures.

Table 4-21: Religious Holidays every Month (excluding Saturday, Sunday)

Day of Month	Religious Holiday	Day of Month	Religious Holiday
1	Ledeta (Holy women)	16	Kidane Mehret (God's Mercy)
3	Bata (Mariam)	17	Abuna Betre Mariam (Holy man)
5	Abo (Holy Spirit)	19	Gabriel (Saint)
6	Arsema (Holy women)	21	Mariam's birthday
7	Selassie (Trinity)	22	Hurael (Angel, Saint)
11	Awune Hara (Father)	23	Giorghis (Saint)
12	Mikael (Saint)	24	Tecle Haïmanot (Holy man)
13	Debre Tabor (Holy place)	27	Medhanyalem (The Son)
14	Abuna Aragawi (Holy man)	29	Bale Egzhiaber (Jesus Christ)
15	Kirkos (Holy man)		

Source: Consultant, from local informants

Cultural anthropologists researching the area have found the strong religious belief system to be paralleled by other supernatural beliefs, including that a class of people termed *buda*[72] possess the "evil eye" (Box 4-3). These age-old beliefs, presumably, are changing to some extent with the advent of links to the outside world and modern media such as radio, and this change will be accelerated by the project as it opens the area to outside influences.

Of relevance to both culture and tourism, the living tradition of manufacture and use of reed boats, *tankwa*, is changing as the raw material (papyrus) becomes harder to obtain.

Box 4-3: The Amhara Peasant's Supernatural World

The Amhara peasant's supernatural world

There are essentially four separate realms of supernatural beliefs. First, there is the dominant Monophysite Christian religion. Second, there are the *zar* and the *adbar* spirits, 'protectors' who exact tribute in return for physical and emotional security and who deal out punishments for failure to recognize them through the practice of the appropriate rituals. Third is the belief in the *buda*, a class of people who possess the evil eye, and who exert a deadly power over the descendants of God's 'chosen children'. The fourth category of beliefs includes the *čiraq* and *satan*, ghouls and devils that prowl the countryside, creating danger to unsuspecting persons who cross their path.

[…] *buda* people can change into hyaenas and roam the countryside at night.

Source: Reminick (1974)

71 The 2003 Convention for the Safeguarding of Intangible Cultural Heritage recognises five "domains" of intangible cultural heritage: (i) oral traditions, (ii) performing arts, (iii) social practices, (iv) traditional knowledge about nature and the universe, and (v) traditional craftsmanship (UNESCO/ARCCH 2007).

72 Traditionally people have been divided into *rega* and *buda. Rega* are righteous, of pure blood, and own land. *Buda* people are landless, and therefore work as potters, weavers and metalworkers. They may be highly skilled, and therefore suspected of supernatural powers.

4.4.10.2 Historical Heritage

Ethiopian historical sources for the mediaeval and post-mediaeval periods of Ethiopian history confirm the significance of the Lake Tana region as a melting pot for different peoples and cultures over many years. From at least the 14^{th} century the region was under pressure from the Amhara Solomonic dynasty rulers, which culminated in the confrontation between the Christian Highland Kingdom and the Muslim sultanates of the eastern lowlands in the 16^{th} century, and finally the settlement and melting of the Oromos into the local fabric.

In the Megech project area a number of place names are evidence of the interaction of different cultural groups, such as Arabia Abba Libanos Kebele near Guramba. The command area is dotted with belief sites (Orthodox church sites with graveyards) some of which claim an antiquity of 500 years or more. The most obvious historical and religious sites are churches and their associated graveyards. Not visible, but historically important, are Dembia Plains battlefields such as Guramba and Gorgora Bichen: the Battle of Guramba is important in modern Ethiopian history, for it was here that the future Tewodros II, the then Kasa of Quara, crushed Daj. Goshu Zewudie of Gojam fighting under Ras Ali. This was on 27 Nov. 1852. Guramba therefore comprises a very significant historical landscape, as does Gorgora Bichen, another successful battle for Tewodros.

The plain north-east of Guramba is very extensive and the precise location of the Guramba battlefield is not clear, although a local elder showed the survey team what he believes to be the site. It is outside the MPIDP command area, but within the command area of the Megech Gravity scheme. As yet, no battlefield archaeological survey has been conducted.

Some important religious sites, such as the Monastery of Debre Sina at Gorgora, will not be directly affected by the project since they are outside the command area (see Annex 9).

Despite their age, many churches in the Amhara region are in good repair due to recent extensive renovation using funds from philanthropists (e.g. Guramba Bata Church at the end of the main canal, Photo 4-29).

Photo 4-29: Guramba Bata Church, Dec. 2009

4.4.10.3 Prehistoric Heritage

The Lake Tana area of north-west Ethiopia is significant in terms of past human experience and ancient cultural developments. There is ample evidence to show that the Lake Tana region has served as a suitable environment for human exploitation of local resources since prehistoric times. However, there are very few scientific papers on the prehistory of the Lake Tana region; most archaeological work has been carried out in the Ethiopian north-eastern Lowlands and north-central Highlands rather than the north-western Highlands.

Two papers exist to indicate the potential of the Megech area for important prehistoric remains: these are Moysey (1943) and Leakey (1943). Colonel Moysey found and excavated a rock shelter on a small hill east of Gorgora, and Louis S. B. Leakey analysed and described the stone tools (mainly waste chips) found at all depths within the shelter. The site showed evidence of continuous occupation by Early Man (Mesolithic onwards). At a similar period, Clark (1945) collected and described stone artefacts (bifaces) from a site east of Gonder.

Discussions with national and international specialists actively involved in archaeology in Ethiopia (see Annex 9) indicated that:

- The Ethiopian Highlands are rich in archaeological and palaeontological sites, but very little work has been done on them.
- Of primary scientific interest is evidence of lithic technologies (stone tools) of *Homo sapiens* and our predecessor *H. erectus*, dating as far back as 700,000 yrs BP. Sites include surface scatter, rock shelters and caves, eroding sediments, campsites, etc. To date, virtually all information on Early Man in Ethiopia has been from the Lowlands. Sites in the Highlands are a new window onto the foraging behaviour of early humans, as evidenced by new discoveries by the Blue Nile Basin Survey Project at Chilga Kernet just west of Gonder (Todd *et al.* 2003).
- Other interests include huge fossil trees (just discovered) near Gonder and worthy of declaration as a national monument (they are so large that they are visible on Google Earth), Oligocene faunal remains up to 27 M yrs old (Kappelmann *at al.* 2003), and palaeobotanical remains. These remains are found in sedimentary deposits on top of the volcanic basalt flood deposits which cover much of the Highlands (< 27 M yrs BP).
- Professors Todd and Kappelman[73] have investigated the area immediately west of Gorgora, but have not written this up yet; the area has significant physical cultural heritage.
- The rock shelter at Gorgora described by Moysey (1943) is close to the command area and therefore might be affected by the Megech Project.
- The main canal from the pumping station will run along the boundary between the flat, wet lowlands and the drier hills to the west and north. This is a prime location for possible archaeological sites (campsites etc.).

The reconnaissance survey carried out for this ESIA study (Annex 9) revisited the rock shelter at Narna Hill and located a number of prehistoric artefacts indicating significant use of the area by Stone Age Man (stone scrapers, other stone artefacts and microlithic debris (chips from the manufacture of stone tools), and circular excavations in solid rock at the summit of hills). Sites visited and evidence of prehistoric use observed were Narna Hill (Photo 4-30), Kurtiye Hill, Abba Taje Hill, and Chehaldibi Hill (Photo 4-31). Locations are mapped in the survey at Annex 9. Choa Terrara (another prominent local hill on the edge of the command area) was not visited but satellite imagery clearly shows the presence of enclosures at the summit. Their date is not known.

Photo 4-30: Narna Hill, site of rock shelter used by Early Man, and excavations near summit


Photo 4-31: Chehaldibi Hill: microliths, a stone enclosure and excavation at summit


73 See Annex 2 for affiliation and contact points.

4.5 SIMILAR PROJECTS IN THE REGION

4.5.1 Koga Irrigation Project

The Koga Irrigation and Watershed Management Project is under implementation on the Koga River, a tributary of the Gilgel Abbay River which is the main influent on the south side of Lake Tana. The scheme depends on a low dam and shallow reservoir (capacity ~ 1.2 million m^3: Photo 4-32) to irrigate some 7,000 ha. The scheme is based on smallholder agriculture and involves up to 14,000 beneficiary households. The total value of the works is some USD 38 million, of which USD 34 million is sourced from the African Development Fund (ADF) of the African Development Bank.

Photo 4-32: Koga Dam and reservoir

Construction of the dam, reservoir, canals and associated infrastructure such as service roads requires some 1,406 ha of land. As of late 2007, 908 ha had been acquired and 5,075 households compensated for the loss of land or assets, including crops and trees (Ayalew Gebre *et al.* 2008a).

The dam and the majority of the canal infrastructure have now been completed after an extended construction period, and operation of the scheme is commencing.

During construction the project's supervising engineers raised concerns about a lack of attention to farmer consultation, organisation and training, together with lack of resources for capacity building in the responsible land, water and agriculture offices at woreda and kebele level (Mott MacDonald 2005). An independent stakeholder analysis carried out in 2007 echoed these concerns, with further issues arising in relation to compensation, resettlement, and inadequate investment in the dam's catchment area (Ayalew Gebre *et al.* 2008a; see also Wubneh Belete Abebe *et al.* 2008 concerning weaknesses in implementation of the project's environmental management plan). Interestingly, the stakeholder analysis found that:

> "*All the stakeholders agree on another key issue related to dam planning and operation. They all lament that serious errors of judgement were committed in the setting of priorities. They believe that the scheme was initiated without the necessary advanced planning and preparatory work. Thus, while the physical and engineering aspects of the scheme have been dealt with adequately, their perception is that the social and environmental issues have been given minimal attention. As a result, the work undertaken in the areas of stakeholder analysis, property valuation, compensation payments, community mobilization and awareness creation, and environmental monitoring and management has to date been inadequate. Surprisingly, it does not seem that lessons have been learned from past mistakes*."

A rapid appraisal of the project by the ESIA study team in April 2010 found that the reservoir had not filled completely, livestock no longer had access to some grazing areas since they had been flooded by the partly-filled reservoir, but nevertheless the availability of irrigation water (either via hand-dug quaternary canals or by pumping directly from main canals) had resulted in some dry-season production benefits for some farmers, especially potatoes and tomatoes - although with depression of local prices due to market inelasticity. The team also found that local residents had no idea how to run the scheme, open canal regulators, or distribute the available water, indicating an ongoing lack of organisation and training.

4.5.2 Other Irrigation Projects

Other large-scale irrigation projects planned for the Lake Tana basin are listed in Chapter 6.

A Stakeholders Consultation Workshop on the Megech Pump (Seraba) Irrigation and Drainage Project held by the project design consultant in Gonder identified a number of lessons that can be learned from existing projects in the region. The following three factors were identified as the main reasons for the failure of small and medium scale irrigation projects in the region (Tahal-CECE 2010):

Some schemes had to be shut down at the farmers' request, because they were designed and built without any interaction with them.

Other schemes had to be abandoned because of technical failures and a lack of maintenance.

Still other schemes did not function properly because of a lack of sense of ownership on the part of the farmers.

5. Impact Analysis

5.1 Introduction

This chapter presents the study team's assessment of the impacts likely to arise as a result of implementing the project. For each impact, the analysis is based on the nature of the issue, the predicted impact, its extent, duration, intensity and probability, and the stakeholders and/or values affected. To avoid excessive chapter length, the text is presented in abbreviated form.

In accordance with best practice, the analysis includes issues relating to the project's environmental and social sustainability.

For potential negative impacts judged by the study team to be significant and requiring mitigation, the analysis is followed by notes on mitigation options and an estimate of residual impacts (after realistic mitigation).

Impacts and their possible mitigation are combined in this chapter, for easy reference.

Although the impacts and analyses are quantified as far as possible, many of the impacts of the MPIDP will be indirect. In these cases, and also in terms of 'significance', a qualitative assessment is necessary. These assessments - value judgements - are the study team's professional opinion based on extensive experience of impact assessment and rural development.

As in most impact studies, the analyses focus on potential problems and their solutions rather than on the project's overall benefits. However, where opportunities for enhancement occur (a major gain for a minor cost), these are identified and outlined.

The analysis is divided into two main sections: the Construction Phase and the Operation Phase. Within each section, issues are listed in the following general sequence: physical, biological, social, economic and institutional. Cumulative and transboundary effects, and alternatives, are discussed in Chapters 6 and 7, respectively.

It should be noted that solutions to many of the issues discussed need to be implemented now, during the project's Pre-construction Phase. Appropriate actions, by project phase, are included in the ESMP (Chapter 8), and recommended immediate next steps are highlighted in Chapter 9.

5.2 Summary of Impacts

Firstly, the project's positive impacts and anticipated benefits during operation are summarised in Table 5-1. In addition, there will be a short-term benefit during construction of construction-related employment and provision of the associated goods and services.

Secondly, negative impacts which are unlikely to occur as a result of the project are listed in Table 5-2. These impacts are either (i) not relevant, or (ii) easily controlled by standard best practice (e.g. design against earthquakes, or controlled use of explosives for blasting foundation rock), or (iii) not considered to be relevant to project decision-making at this stage. They are not considered further in this ESIA.

Thirdly, key potential negative impacts in the absence of mitigation are summarised in Table 5-3. Other impacts are also associated with the project but are of less importance. Full lists are given in Table 5-4 and Table 5-5 covering the construction and operation phases, respectively, and discussed in detail in the accompanying text. The tables also include a number of *issues* related to both phases; these are not predicted impacts, but are topics requiring consideration when planning the project's environmental and social management.

Table 5-1: Planned and Anticipated Positive Impacts of MPIDP during Operation

Planned
Increased cropping intensity on some 4,000 ha due to the provision of dry season irrigation water
Increased crop yields due to improved drainage, inputs and crop husbandry
Increased crop diversity due to an improvement of land capability by irrigation and drainage and improved access to seeds and markets
Improved livestock husbandry and productivity
Increased and stabilised household incomes from agriculture for some 2,200 farm households
Increased secondary economic activities - agriculturally-related goods and services - and associated local employment, including for scheme operation and maintenance
Improved institutional capacity of government organisations responsible for water management and agricultural development at regional, woreda and kebele levels
Improved road access, with many associated benefits
Social development, particularly due to the establishment and operation of democratic, gender-sensitive and transparent water management organisations at different levels
Reduced impacts from flooding
Anticipated, subject to implementation of relevant community development and ecosystem conservation measures
Improved adult literacy in command area due to adult literacy programmes
Improved health for command area households due to multiple health initiatives, combined with improved literacy, women's status, road access and household incomes
Improved status and quality of life of women in the command area due to multiple community development initiatives especially provision of domestic water supplies, increased household incomes, adult literacy, improved health, better access to fuel and inclusion in community decision-making mechanisms
Conservation of fish and wildlife in command area and associated rivers due to establishment of habitat protection and fishery management mechanisms and increased environmental awareness
Restoration of lakeshore ecosystem functions adjacent to command area due to lakeshore restoration programme

Source: Consultant

Table 5-2: Negative Impacts Unlikely to Occur and not Considered Further

Construction	**Operation**
Air pollution (except dust) *Rural area, good air quality, dispersed emissions (vehicles, stationary equipment), low density of receptors)*	Limitations on irrigation water supply (but see Chapter 6 Cumulative Effects) *Water source is Lake Tana and project is relatively small*
Unreasonable noise *Rural area, night working unlikely, low density of receptors*	Poor irrigation water quality *Lake Tana water is of good quality for irrigation*
Hazards to public from use of explosives *Limited requirement for excavation of hard rock, rural area, use is regulated*	Disruption of downstream flow regimes *By itself, the project will not have significant effects on Lake Tana's hydrology (but see Chapter 6 Cumulative Effects)*
Slope destabilisation and landslides *Area is low-elevation or flat and not susceptible to mass movements (but is susceptible to surface soil erosion)*	Disruption of downstream water users *Downstream users (between the project and the lake) depend on water from the lake for dry-season agriculture, not from the project rivers*
Loss of forest habitat *No forests in area*	Changes in local climate *The project is unlikely to have any significant effect on local climate*

Construction	Operation
Price inflation of staples during construction *Labour force will be relatively small and unskilled labour will be local*	Earthquake damage to structures *The project structures are small and simple and the area is not considered at risk of severe earthquakes*
	Influx of outsiders due to better access and uncontrollable induced development *All land in the PCA is allocated and surveyed, resources are intensively used, and outsiders are highly unlikely to be permitted entry to this system*

Source: Consultant

Table 5-3: Predicted Key Potential Negative Impacts if Not Mitigated - Summary

Construction Impacts	
• Disruption of habitat of economically important or globally unique fishes • Potential impacts on known & unknown cultural heritage • Disruption of access by new canals and drains • Accidents and health impacts during construction	• Rapid social and economic change due to land reallocation and scheme construction • Difficulties in administering the complex land redistribution process, with possible social resistance • The social impact and cost of village irrigation and potential settlement reorganisation
Operation Impacts	
• Potential delays in irrigated agriculture development • Difficulties with in-field soil & water management • Secondary salinisation of soils • Erosion and sedimentation • Flooding and inadequate flood protection • Inadequate pest management and increased use of hazardous pesticides • Agricultural impacts on water quality • Ongoing impacts on globally important birds and fishes • Cultural constraints preventing rapid social and economic change • Impacts on women, especially increased workloads • Socio-economic impacts of the transformation of livestock husbandry	• Health impacts, especially continuing malaria and an increase in schistosomiasis • Inadequate or delayed provision of essential agricultural services and inputs including research, knowledge, credit, crop storage and processing, and links to markets • Inadequate or delayed provision of essential social services, especially health, water and sanitation, also education, road maintenance, electricity and telecommunications • Difficulties in product sales due to market inelasticity • Lack of affordability by farmers • Price reductions in local markets due to market inelasticity and associated impacts on rain-fed producers • Constraints on access due to new channels and to inadequate road maintenance • Cumulative effects on the quality and volume of water in Lake Tana

Source: Consultant

5.3 Construction Phase

5.3.1 Overview

This section analyses the predicted direct and indirect negative effects of physical construction of the project. Potential Construction Phase impacts are listed in Table 5-4, together with a simple score of their significance *before* mitigation (none/low, medium, high). The table contains a column for the Consultant's recommendation as to whether mitigation is required, which in all cases is "Yes". (Note: in many cases the "YES" in the table reflects standard best practice).

Each impact is then discussed and analysed in the text, under the general headings of construction process, ecology, and socio-economy. These headings are considered more useful than a strict division into physical, biological and social impacts since in many cases construction processes affect all three environmental components.

Table 5-4: Construction Phase Impacts - Summary

No.	Topic	Potential Impact	Significance*			Mitigation Needed?
			None/ Low	Medium	High	
Construction Process						
C1	Contractor's Camps	Temporary loss of land and inadequate physical and social management of camps and workforce		•		YES
C2	Construction Access & Traffic	Unsafe access routes and construction traffic		•		YES
C3	Construction Materials	Permanent loss of land and H&S hazards of operation and closure of borrow pits and quarries		•		YES
		Hazards from toxic materials		•		YES
		Procurement from non-environmentally and socially sensitive suppliers	•			YES
C4	Spoil Disposal	Improper disposal and treatment of dump sites	•			YES
C5	Waste Management and Pollution	Improper disposal of solid and liquid waste		•		YES
		Spills and inadequate clean-up		•		YES
C6	Dust	Dust nuisance or hazard	•			YES
C7	Health & Safety of Workers	Hazards to workers		•		YES
C8	Health & Safety of Public	Hazards to public		•		YES
C9	Flooding during Construction	Hazards to works from floods		•		YES
Ecology						
C10	Loss of habitat	Direct loss of habitat		•		YES
C11	Impacts on wetlands	Habitat impacts due to channelisation and construction in rivers and wetlands, invasive species		•		YES
C12	Impacts on wildlife	Disturbance and exploitation during construction		•		YES

No.	Topic	Potential Impact	Significance*			Mitigation Needed?
			None/ Low	Medium	High	
Socio-economy						
C13	Cultural Heritage	Impacts on known & unknown physical heritage	•			YES
C14	Rapid Change	Social dislocation and social resistance			•	YES
C15	Land Loss	Permanent loss of land and other assets for infrastructure			•	YES
C16	Land Redistribution	Disruption of livelihoods due to reallocation and consolidation of land			•	YES
C17	Village Irrigation	Disruption of settlements & associated impacts & health hazards			•	YES
C18	Disruption of Existing Agriculture	Disruption of crop and livestock production by construction activities			•	YES
C19	Disruption of Access	Disruption of existing access due to new channels			•	YES
C20	Employment	Employment of outsiders		•		YES

***** Significance: before mitigation, Consultant's professional opinion; see text for explanation

Source: Consultant

5.3.2 Construction Process

5.3.2.1 Contractor's Camps and Temporary Land Requirement

Impact C1: the construction contractor will need land to establish camps including site offices, workshops, stores, vehicle parking, and staff accommodation. Other land will be needed temporarily for aggregate processing and concrete manufacture, metal fabrication, back-up power generation, and access.

Analysis: the total temporary land requirement will be less than 2 ha in several locations including at the pumping station site (Wawa) and in a non-flooding area within or near the edge of the command area east of the Dirma River. The land will be required for up to 24 months, unless construction is extended to a more realistic 36 months. The camp sites will be foci for noise, dust, lights, economic activity, waste generation and potential pollution, all on a relatively small scale. They will also attract service providers. Exact locations have not been determined at this time. Existing land users may be farmers or herders.

Mitigation options:

- Land of lowest value (non-cultivable) should be allocated for the contractor's main camp, if possible.
- Establish a mandatory entitlement related to temporary land loss in the RAP Entitlement Matrix, compensation for lost crops and improvements, annual income as long as the land is needed, and land reinstatement to its original condition (this has been done).
- All the contractor's facilities will require best practice management in terms of both "housekeeping" (site cleanliness, waste disposal etc.: see example of Checklist at Annex 10.3) and social management (see Impact C5).
- Require the construction contractor to employ a full-time Community Relations Officer and to establish and implement a formal Social Responsibility system in line with ISO 26000 or SA 8000.
- The contractor's facilities should be completely removed before the end of the contract, unless required by the Employer, and the land restored to its previous condition or better. Note that satisfactory site restoration requires pre-planning (e.g. topsoil removal and storage) and tight contract supervision.

- The Employer (MoWE) should consider whether to require the contractor to build his offices and camp to a permanent standard so that it can be handed over to government for other purposes on completion of the project (for example, as an HQ for project operation and maintenance, in addition to the planned administration compound).

Residual significance: nil negative (subject to effective management and mitigation); highly positive if facilities are built to good standard and transferred in good condition to a subsequent user.

5.3.2.2 Impacts of Construction Access & Traffic

Impact C2: (a) the construction contractor will need to access the site of the permanent and temporary works by constructing permanent and temporary access tracks, and (b) light and heavy construction traffic will use both public roads and the contractor's temporary roads, with associated potential damage to public roads and traffic-related health and safety issues.

Analysis: the construction contractor will need access to the site of the pumping station and its approach channel, to the main canal and all other canals and drains, to the reservoir sites and river crossings, along all the major rivers for channelisation and dyking, to his own camps and yards, and to project-related borrow pits, quarries and spoil disposal sites. Some of the access roads will become permanent roads as part of the project (e.g. the pumping station access, the service roads along the canals). For construction, access will be needed throughout the PCA. The layout of the permanent road network has been established (Drawing C.5-1 in the FS). Temporary access will be required across cultivated land, involving potential loss of crops and soil compaction, across and along rivers and small channels, and up to the edge of retained wetlands.

Construction traffic will vary from fast, light 4WD vehicles used for transport of supervisors through minibuses and pickups to wheeled and tracked excavators, fuel tankers, and tipping trucks (dump trucks). The tipping trucks are likely to be road vehicles rather than specialised low ground pressure dump trucks, with lower performance under adverse ground conditions and higher capacity for soil compaction. No information on the number of vehicle movements is available. However, compared to existing low levels, traffic on the unpaved Kola Diba to Gorgora and Kola Diba to Guramba roads will increase significantly. The increase will initially affect the Gorgora road (Phase I development), followed in the second and third years by the Guramba road (Phase II development). At present both roads are passable. Heavy construction traffic is likely to cause rapid deterioration of both roads if they are used by loaded vehicles during and immediately after rain, especially the track to Guramba.

Mitigation options:

- Consideration should be given to including repairs to and maintenance of the unpaved Kola Diba to Guramba road in the construction contract.
- Maximum use should be made of future permanent roads for site access.
- Rights of way for temporary access must be negotiated with all affected individual users, and any temporary loss of land compensated in accordance with mandatory procedures included in the RAP's Entitlement Matrix (compensation for lost crops and improvements, annual income as long as the land is needed, and land reinstatement to its original condition; this has been done).
- Temporary access should not be permitted in the wetlands along the Dirma River.
- The condition of all non-paved public roads and all temporary access routes should be recorded and agreed with the concerned authorities and/or land users before use, with both written and photographic evidence.
- Any damage to public roads should be made good to the satisfaction of the road authority immediately it occurs and at the latest before the end of the contract.
- The condition of all access roads should be checked regularly and repairs made as necessary.
- After use, all temporary access routes on cultivated land or pasture (grassland) should be restored to their previous condition or better. This will involve (i) the removal of all non-soil material, (ii) deep ripping to relieve compaction; and (iii) the replacement of topsoil if this has been destroyed or removed.
- Speed limits should be imposed and enforced on all vehicles operating on haul routes.
- Safe sight distances should be established at junctions and within construction areas and construction camps.
- A detailed plan for signage around the construction areas to facilitate traffic movement, provide directions to the various work sites, and provide safety advice and warnings should be prepared and implemented (all road sections should have signs with permissible speed limits, all signs shall be in both Amharic and English).

- Special loads, such as wide, very heavy or hazardous materials, should be subject to specific movement plans.
- All personnel on Site should be briefed on construction traffic rules and procedures.
- Local residents, especially children and their parents, should be informed about construction traffic hazards.
- All accidents involving construction traffic should be recorded and reported, with follow-up to improve procedures as appropriate.

Note: typically these measures are included in a Traffic Management Plan to be developed by the construction contractor and approved by the Engineer (the PSP contractor) on behalf of the Employer (MoWE).

Residual significance: nil negative (subject to effective mitigation).

5.3.2.3 Impacts of obtaining Construction Materials

Impact C3: (a) the construction contractor will require bulk materials for construction, specifically earth for embankments, stone for stone pitching, stonework and rip-rap (channel bed and bank protection)), and various grades of aggregates (sand, gravel, crushed rock) for road construction and concrete; these will have to be sourced locally; (b) there is a small possibility that asbestos-cement or other asbestos containing materials might be used in the Works; (c) materials suppliers (both national and international) have varying standards with respect to all aspects of corporate social responsibility (CSR), the most important of which relate to health and safety but which also cover, e.g., child labour, environmental protection, and community relations; therefore some purchased materials might come from sub-standard suppliers (off-site environmental and social impacts).

Analysis:

(a) The project requires some 1.1 million m^3 of fill (mostly for embankments), some 132,000 m^3 of capping layer and wearing course for the roads[74], and smaller quantities of granular fill, stone and sand for concrete and structures. Specific sources for this material are not identified in the available documentation. Some of the soil for embankments will come from excavation of the main canal, but not all will be suitable. The project will require both borrow pits (for fill) and quarries (for rock). The project will also require sand. Possible sources of construction material have been identified in MPIDP Detailed Design Report as follows (for locations see Annex 1, Map 7):

- Borrow / selected material: 3 locations between Gorgora and Kola Diba.
- Rock for stonework (porphyritic basalt): near Kola Diba.
- Rock for crushed aggregates: none suitable locally, purchase from Gonder.
- Sand: bed of Megech River or from the Mariam Wuha River (45 km west towards Delgi); however, this sand is unsatisfactory, so it is recommended that sand be purchased from the Gonder area unless further tests prove it is acceptable.

All borrow pits and quarries need to be sited, accessed, operated and closed so as to avoid archaeologically sensitive sites, minimise impacts on land users and avoid the creation of safety or health hazards (e.g. steep slopes, malarial ponds). New borrow pits and quarries need prior approval from the local administration. Sand is already mined from the new Megech River (Photo 5-1): 1 quintal (100 kg) of "thin sand" (*ashoa*) for cement sells for about ETB 900 locally; in Gonder the same quintal fetches about ETB 3,000. Sand mining is an important activity locally, especially for landless youth. However, sand extraction from rivers is associated with habitat destruction due to changes in channel morphology.

[74] Data from draft MPIDP BoQ (Tahal-CECE 2010).

Photo 5-1: Sand mined from bed of new Megech River, March 2010

(b) The World Bank has policies and guidelines in place to avoid the use of new asbestos-containing materials in projects which it funds.

(c) With the rapid spread of social accountability, elements of supply-chain analysis for social and environmental impacts is rapidly becoming a standard procedure on major internationally-funded projects, and is no longer regarded as a "liberal luxury". Reputable manufacturers are increasingly familiar with this type of quality control, for example suppliers to the European Union, a very large market, must make a legally binding "Declaration of Conformity" with EU health, safety and environmental Directives for their products. Although this is done to protect EU end-users, the approach is now being extended through widespread application of CSR procedures by major manufacturing companies, assisted by certifiable standards such as SA 8000 and the guidance available in the draft ISO standard 26000[75].

Mitigation options:

(a) Borrow pits and quarries

- Maximise the re-use of excavated materials in the Works, as fill (this is standard practice).
- Site quarries and borrow pits carefully so as to minimise impacts on existing land users.
- Obtain archaeological clearance for all proposed borrow pits and quarries, in advance.
- Strip all available topsoil from borrow pits and quarries and store it safely for use in site restoration.
- Operate quarries and borrow pits so as to (i) avoid the creation of steep slopes hazardous to livestock and children, and (ii) keep them drained so as to avoid the creation of potentially malarial pools.
- Close all borrow pits and quarries in accordance with an approved plan to maximise their long-term biological productivity (capacity for plant growth) and minimise health and safety hazards.
- Ensure sand is only sourced from sources with both woreda and ANRS BoEPLAU approval.

(b) Asbestos

- Ban all use of asbestos-containing products (clause in the tender documents).

(c) Socially responsible procurement

- Include a provision in the tender documents that where goods and services are of equal quality, those sourced from an organisation implementing a certified EMS and/or CSR approach will be preferred.

Residual significance: (a) low negative (not fully mitigable); (b) nil; (c) positive, if implemented.

[75] SA 8000: a certifiable standard developed by Social Accountability International; ISO 26000 Guidance on social responsibility: an ISO Standard, now at "Final Draft" stage and scheduled for publication in 2010.

5.3.2.4 Impacts of Spoil Disposal

Impact C4: the project will involve the excavation of soil and rock surplus to requirements for fill or unsuitable for re-use in the Works. This will require disposal, taking up land and possibly creating a source of sediment.

Analysis: the project will have a requirement for disposal of some 280,000 m^3 of spoil (i.e. the equivalent of 14 ha to a depth of 2 m or 7 ha to a depth of 4 m). Unmanaged disposal of spoil can result in sterilisation of productive land and the creation of ongoing erosion, sedimentation or drainage problems; it may also affect unknown archaeological heritage. In the project area all cultivable land is in use for cropping and virtually all other land is used for grazing. Disposal of spoil may create an opportunity for improving land by raising it above flood levels (for example, if the material is suitable, by creating raised platforms for housing and other buildings in settlements, or for amending infertile soils), but any such activity would have to be carefully planned and managed to achieve sustainable results.

Mitigation options:

- Maximise the re-use of all excavated materials in the Works (this is standard practice).
- Dispose of surplus material ("spoil") only at designated sites approved by the responsible local authority and only by approved methods; if agricultural, these methods must consider topsoil conservation and quality; if infrastructural, these methods must consider long-term soil stability against shrinking and swelling; in all cases steps must be taken to prevent erosion and maintain the stability of the material after placement.
- To protect ecological values and water quality, no spoil should be disposed of in wetlands or in or near watercourses.
- Obtain archaeological clearance for all potential spoil disposal sites in advance.

Residual significance: nil to low negative, potential for positive if used to improve land.

5.3.2.5 Waste Management and Pollution

Impact C5: the construction process will involve the creation of various solid and liquid wastes and the use of hazardous materials (fuels, oils and solvents) in and near sensitive water environments.

Analysis:

(a) Construction will result in the creation of (i) various solid wastes, principally surplus earth and rock (discussed at 5.3.2.4 above), metal scraps, plastics (wrappings and containers), cardboard, paper, wood (mainly from shuttering (formwork)), office wastes including e.g. used toner cartridges, kitchen (canteen) wastes, workshop wastes including e.g. used oil filters, and waste concrete, (ii) various liquid wastes including used oils and solvents, grey and black water (respectively washing water and sewage), concrete washings, runoff from camp and workshop areas, and various liquid waste streams from construction processes - vehicle washing, sand and gravel processing, dewatering excavations, etc. The project will also involve the use of stationary and mobile plant and equipment requiring refuelling, mainly with diesel, and the construction of permanent and temporary fuel storage.

(b) The project will involve working in and near water by heavy equipment (excavators, dozers and dump-trucks). There will be a small water-based activity for construction of the pumping station's intake channel on the edge of the lake.

Note: the potential ecological impacts of the channelisation process are analysed in Section 5.3.3.1.

(c) As with any construction activity there is the possibility of accidents and spills, the two most likely being contamination of soil by used engine oils and the spillage of diesel from mobile bowsers. Contaminated soil is injurious to plant growth and must be removed. Contamination of water is potentially more serious since pollutants may move fast and the receiving environment is highly sensitive (e.g. migrating fish, international migratory birds, water used by livestock, Lake Tana).

Mitigation options:

(a) Waste management

- Effective waste management requires the identification of all waste streams, development of appropriate management methods based on the three Rs (reduce, re-use, recycle), institution of the system together with the necessary staff training, and full record keeping. On large construction projects this is done through a formal Site Waste Management Plan. The scale of the project and the sensitivity of the receiving environment suggest that this approach would be appropriate for MPIDP.

(b) Pollution prevention and working in water

- The risk of accidents involving hazardous materials such as fuel can be minimised by a standard best practice approach involving such basic precautions as 105% secondary containment of all stationary fuel stores, vehicle maintenance only on purpose-built impervious concrete platforms with oil and grease traps, and standard operating practices for refuelling mobile equipment such as a minimum 25 m from any water channel. Operator training is an important aspect of this preventive approach.
- Standard operating procedures for working in and near water should be implemented based on (i) ecological clearance for the activity (based on seasonality), (ii) minimising wading (machines passing through and operating in water), (iii) ensuring all equipment is in good condition, clean and free from leaks, (iv) maintaining flows through the works (if applicable).

(c) Environmental emergency response

- Oil spill containment and cleanup equipment should be kept at the pumping station and at one or more other locations east of the Dirma River, with a small kit in every project vehicle.
- Selected staff should be trained in full use of the kit, and all staff to foreman level should be trained in immediate response using vehicle kits and in emergency communication procedures (see Section 5.3.2.7).

Residual significance: nil to low negative (there will, inevitably, be some spills and accidents during construction).

5.3.2.6 Dust Nuisance and Hazard

Impact C6: most construction activities will be carried out in the dry season, and it can be expected that these will generate some dust.

Analysis: the principal dust sources will be (i) vehicles travelling on unpaved roads and tracks, and (ii) dust from exposed, non-vegetated surfaces. Some dust will also be generated during blasting and excavation works, by blowing from dump truck loads, and possibly from project borrow pits and quarries. Dust from the infrequent vehicles travelling on unpaved roads is already a nuisance to any pedestrian walking on the road (walking is the most common method of travel in the area). Project traffic will add significantly to vehicle numbers, since there are so few at present. However, the dispersed nature of the works and relatively low population densities (in terms of clusters of houses by roads travelled by project vehicles) suggest that dust is unlikely to be a significant nuisance to residents, or a health hazard.

Mitigation options:

- Identify settled areas on project access routes west and south of Kola Diba, and establish specific maximum speeds for project vehicles through these areas (e.g. Chuahit, Guramba).
- In the event of dust nuisance, water the access roads or works.
- Re-vegetate exposed earth surfaces as soon as feasible (first rainy season after construction).

Residual significance: nil negative.

5.3.2.7 Hazards to Workers

Impact C7: to build the project several hundred workers will be involved in construction activities over an estimated three years. This is highly likely to result in accidents and injuries to workers. In addition, construction workers are often involved in risky behaviour off-site and therefore potentially subject to high rates of HIV transmission, and construction involves processes and environmental modifications which may cause disease hazards.

Analysis:

(a) Construction is a high-risk occupation, and casual observation of construction sites in Ethiopia reveals widespread non-observance of even the most basic safety measures and a lack of personal protective equipment (PPE). Such low standards inevitably result in accidents, injuries and occupational health problems which are completely avoidable with simple precautions. On this project accidents may occur at the construction sites including when working in or over water, at the construction camp and workshops, and during travel to and around the site. H&S issues may also occur at project-related borrow pits and quarries. International financing, construction and operation provides an opportunity to raise H&S standards on this project, but this requires a conscious decision by the project proponent and financing agency prior to tendering.

(b) Ambulance services are non-existent in the PCA, and the nearest hospital with emergency services is in Gonder with a referral hospital in Bahir Dar. Better services are available in Addis Ababa, some 14 hours by road.

(c) Many construction workers are males living away from home and with money in their pockets; depending on local cultural circumstances, and as frequently observed elsewhere in Africa and around the world, this can result in risky sexual behaviour and high rates of transmission of HIV and other STDs.

(d) Construction involves processes such as construction and operation of camps and canteens, and environmental modifications such as quarrying. These processes and features may increase disease hazards, for example through increased proximity of workers in their accommodation resulting in increased risk of transmission of infectious diseases such as TB, incorrect food storage and preparation, or the creation of pools of water where disease vectors (mosquitoes) could breed.

Mitigation options:

(a) Health and Safety on site

- Ensure that the project proponent and financier signal that best practice H&S standards should apply to this project (policy leadership).
- Include standard best practice health and safety provisions in the construction contract, together with (i) appropriate BoQ items so that at least some elements of H&S are pay items (financial incentive), (ii) a mechanism for withholding payments if the contractor is not compliant with the H&S provisions. Note that the provisions should include insurance to enable the contractor to pay for any and all treatments required by his workers including those of all sub-contractors, together with any subsequent lifelong disability payments.
- Include a specific task in the supervision contract concerning H&S supervision and compliance, together with the staff resources to carry this out, and possibly including a training task for the Employer's staff.
- Implement the specified H&S programme throughout the construction period.

(b) Emergency evacuation

- Establish an emergency evacuation procedure for casualties to an approved hospital. This is likely to require (i) one 4WD vehicle on site equipped as an ambulance, (ii) a paramedic on site at all times during construction activities, and (iii) arrangements for air evacuation to Addis Abeba or internationally.

(c) HIV/AIDS

- AIDS test (and TB) for all staff and workers, and provide anti-retroviral drugs to all workers testing HIV+.
- Compulsory HIV/AIDS and STD awareness and prevention training for all workers including truck drivers delivering supplies to the site (IEC: information, education, communication), and including free access to condoms (this is a standard World Bank requirement).
- An "alleviation programme" for site staff and labour and their families with respect to STDs and HIV/AIDS (this is a standard World Bank requirement).
- Establish close links with the Dembia Woreda health office to minimise the establishment of new brothels and other forms of prostitution (see Section 5.3.2.8).

(d) Diseases during construction

- Ensure tender documents include standard best practice clauses for topics ranging from accommodation to waste management and quarry and borrow-pit operation and closure.

Residual significance: high, in terms of avoided accidents, injuries, occupational health problems, and deaths (although there will still be some incidents).

5.3.2.8 Hazards to Public (Local Residents)

Impact C8: the public as well as workers are at risk from major civil engineering projects such as MPIDP, particularly (a) from construction traffic, and (b) local women through sexually transmitted diseases.

Analysis:

(a) The project will generate a large amount of traffic compared to the non-project situation. Some of this will be travelling on the public roads, some will be travelling on new roads or unmade tracks within the PCA where, until now, there has been no traffic. Accidents could occur due to excessive speeds, unsafe loading, poor road surfaces, poor vehicle maintenance, livestock, and unwary pedestrians, especially children not used to vehicles and drunken men.

(b) Local women are, in general, extremely poor, marginalised, male dominated, and illiterate. It is highly likely that some will become prostitutes to take advantage of the cash available to male project workers. Because of their low status and lack of knowledge, it is likely that will be involved in unsafe sex and therefore be at high risk of becoming infected with (and subsequently passing on) HIV. This is an important gender issue.

Mitigation:

(a) Construction traffic hazards to public

- Establish and enforce a strict code of conduct for all project drivers including outside suppliers delivering materials. The code should focus on safety, especially speed, and loading, especially banning all carriage of staff, workers and passengers except in seats. It could be in the form of a Traffic Management Plan.

(b) Prostitution and HIV/AIDS

- Establish and implement an HIV/AIDS prevention programme specifically related to the project's construction phase (a standard World Bank requirement). The programme should include, at a minimum, (i) the identification of specific risk groups (e.g. bar workers in Kola Diba, truck drivers), (ii) specific AIDS awareness campaigns for these risk groups, (iii) HIV/AIDS tests for identified sex workers and the provision of retro-virals.
- Minimise the opening of new brothels to service the workforce.

Notes: other hazards such as possible creation of mosquito-breeding sites can be avoided through the use of standard best practice clauses in the tender documents. Some of these measures could be incorporated into a Public Health and Public Safety Awareness Plan.

Significance: (a) nil to low negative (there will still be accidents), but positive (in terms of avoided accidents (an unknown number)); (b) highly positive (in terms of avoided HIV transmission).

5.3.2.9 Flooding during Construction

Impact C9: the project involves the construction of many 100 km of channels and associated structures in a floodplain subject to annual floods of varying severity and duration.

Analysis: the pumping station and access road will be above annual flood levels and in no danger from runoff or flooding; the first 5.28 km of the main canal will be built on sloping ground crossed by a number of seasonal watercourses, and therefore at risk from cross-flows; the remainder of the main canal and all remaining channels (secondary canals, drains) and related infrastructure (reservoirs, siphons, turnouts, service roads, dykes etc.) will be built in the flood-prone floodplain and subject to varying degrees of inundation; the service roads and other roads in the project area are unpaved and some will be unsurfaced; severe damage can be caused to these roads if trafficked when wet.

Mitigation options:

- Confine work on at-risk structures (the majority) to the dry season, i.e. October to May.
- Ensure that all channels and structures are completed by the end of the dry season, or protected from harm by temporary armouring or other protection.
- Plan for and implement comprehensive re-vegetation measures on all exposed surfaces as soon as weather conditions permit (usually May).

Residual significance: nil to low negative, assuming effective mitigation.

5.3.3 Ecology

5.3.3.1 Direct Loss of Habitats

Impact C10: enlargement (channelisation) and dyking of the Dirma and Nededit Rivers for drainage will change the configuration of the river beds and destroy the existing vegetation on the banks. It will also reduce or sever hydrological connections to the riverine wetlands and some seasonally flooded grasslands, and could alter the morphology of confluences with tributaries. These changes will directly affect reproduction of the fishes in the command area and upstream tributaries and consequently the fish stock of the northern part of the lake. Other groups of fauna could be affected by the works, especially wetland-dependent amphibians and reptiles.

Analysis: construction of the works will reduce available feeding and breeding habitat for catfish and Tilapia, and is likely to affect access to upstream spawning sites for migratory fishes of the genus *Labeobarbus* which are unique to the Lake Tana basin, scientifically and economically important, and under threat. Channelisation and bunding of the existing natural watercourses will change river channel morphology and is likely to reduce the depth of flows for a given discharge, potentially reducing the period when fish movement both upstream and downstream is possible (~ 20 cm depth is required for adult *Labeobarbus*). This will have an ongoing effect and is discussed later (see Impact O20). The immediate effect will be dependent on the season, with much greater impacts if work is carried out during the fish breeding season (principally April to October). Given the importance of these habitats to unique fish (see 4.3.4.6), the project clearly triggers OP 4.04 Natural Habitats.

Mitigation options:

- Ensure the detailed design maintains effective hydraulic connections between all tributaries and the Dirma River, and between the Dirma River and its associated wetlands.
- Implement construction activities during the dry season between October and April to avoid the breeding season of the majority of fish species, which is the wet season. The most important period during which to avoid work in rivers and tributaries is from June to September (this is highly important for Labeobarbus species).
- Avoid all construction activities within key habitats, especially (i) the riverine wetland along the Dirma River, and (ii) the lakeshore wetland.
- Construction zone limits should be identified and physically marked, to avoid (or at least minimise) off-site trafficking and damage.

Residual significance: channelisation cannot be fully mitigated, therefore the residual impact will be adverse; the severity of the residual impact is difficult to judge since it will be dependent on external factors upstream of the command area such as watershed management, stream conditions, and diversions.

5.3.3.2 Impacts of Construction in Rivers and Wetlands

Impact C11: construction of the project will involve working in and near water, specifically (a) in Lake Tana - excavation of the intake channel and placement of its side embankments; (b) construction of crossings - seasonal streams under the main canal, the main canal under the Dirma River, secondary canal cross-drainage, and service road crossings; and (c) channelisation and dyking of the Dirma and Nededit Rivers. These activities may temporarily degrade water quality and physically alter or block fish movement. They may also introduce invasive species, if construction equipment acts as a carrier of seeds, etc.

Analysis:

(a) The pumping station intake will extend for 300 m into the lake; some of this distance will require underwater excavation; in the absence of dredgers on Lake Tana, excavation will be by tracked excavator standing on a barge, or alternatively by long-arm excavator standing on the rock berms which will be constructed on each side of the intake channel; some drilling and blasting may be required for construction of the associated wet well, which is likely to require a coffer dam (a temporary dam to keep the construction location dry). The impacts will be localised and the local habitat is not as sensitive as the lakeshore wetlands to the north.

(b) The project involves construction of a significant number of crossings: the main canal crosses some 17 watercourses, mostly seasonal, and the Dirma and Nededit Rivers; the secondary canals require 20 drainage siphons; and both the main and secondary canals will be paralleled by service roads which will cross the same watercourses by fords or "Irish crossings" (ventilated fords, i.e. a series of culvert pipes for low and normal flows with a concreted ford laid above them, over which flood flows can pass). In addition, construction traffic will frequently cross all these tributaries and rivers throughout the construction period since they will provide the principal or only access to most construction sites. These activities have the potential for (i) significant degradation of water quality through the mobilisation of sediment from earthworks and construction traffic, and from oils and fuels if spilt, and (ii) physical blockage or alteration of flows. Sediment is naturally high during floods when almost all erosion and sediment transport occurs, but not at other times. Therefore construction activities have the potential to directly harm fish movement, breeding and habitats; the impacts will be highly seasonally-dependent. The long-term impact of the crossings on fish is discussed under Impact O20.

(c) The Dirma and Kirsit Rivers will be channelised and dyked to safely pass a 1 in 10 year flood; due to the high cost of excavation, part of the capacity increase will be achieved by the construction of flood dykes on each side of the rivers. This process will involve excavators, bulldozers, compactors, fuel trucks and service vehicles moving along and completely altering the existing physical form of the river channels, including through the riverine wetlands which are important habitats. As with (b), the direct impacts of construction in the rivers and wetlands will be seasonally-dependent. The Nededit River will be diverted to the old bed of the Megech River north of the command area by the Megech Gravity Irrigation Project.

(d) Lake Tana is at risk from invasive species of plants and animals. Specific risks include (i) introduction of alien fish to the lake, and (ii) introduction of water hyacinth (*Eichhornia crassipes*), a major problem on some other lakes in Ethiopia. The water fern *Azolla* (used to fertilise rice fields) has already been introduced to the sub-basin by the agricultural authorities; its potential effect on the lake is not known.

Mitigation options:

(a) Working in Lake Tana

- Implement standard operating procedures (SOPs) for working in and on water, including checks on equipment condition (especially leaks of oils, fuel, hydraulics), refuelling protocols (at safe location away from water, availability of spill kits and knowledge of their use, and emergency spill procedures.
- Apply standard best practice site sediment control procedures (e.g. sediment catch pits, straw filters. settling ponds and related measures, as appropriate) to minimise sediment in site drainage waters returning to the lake.

(b) Construction of crossings, and traffic movement across watercourses, and

(c) Channelisation and dyking works

- Carry out all works in the dry season.
- Maintain uninterrupted passage for fish when constructing major works such as the Dirma siphon.
- Implement SOPs for working in and near water, including (in addition to equipment condition checks, spill kits, etc.) a ban on washing vehicles in or near natural waters.
- Ensure all staff and workers are fully aware of the limits to the site for each activity, SOPs, and emergency procedures.

(d) Invasive species

- Ensure that all construction equipment and vehicles entering the Lake Tana sub-basin are clean and completely free of mud and therefore any plant or animal materials (spores, seeds). This could be done by establishing a vehicle cleaning station outside the sub-basin (on the road from Addis Abeba) with pressure-washing equipment, and inspection and certification for biosafety by BoEPLAU or BoARD personnel before the vehicles and/or equipment are allowed to proceed to the Site. In discussion, this procedure appeared unfeasible due to organisational constraints. The suggested alternative is to (i) require the contractor to thoroughly clean all equipment, machinery and vehicles before entering the Lake Tana sub-basin, (ii) to inspect all such equipment when it arrives on Site and before deployment, (iii) any muddy/unclean equipment to be pressure washed on a concrete pad with all drainage water collected in infiltration ponds (not permitted to run off) and the associated sediment (mud) disposed of by deep burial (below germination depth), for example at the base of a spoil disposal site.

Residual significance: short term adverse, nil long-term (but see Operational Impact O20).

5.3.3.3 Disturbance and Exploitation of Wildlife

Impact C12: the construction process will create noise, dust, lights, vehicle movements, and human activities throughout the command area and associated works sites. It will also improve access to sensitive habitats and provide potential additional markets for natural resources.

Analysis: construction is likely to involve blasting and attendant noise, including (possibly) hydraulic rock-pickers; frequent heavy vehicle movements and associated noise and dust; bright night-time lights (for security) at the contractor's main camp and the site of the pumping station; increased movement of humans and light vehicles; and the creation of potential markets for fish, papyrus and other natural products (workforce with cash). These activities may disturb sensitive species, especially migratory birds using the area for winter roosting, breeding and feeding. The impact of disturbance on ecological values is hard to predict: clearly it will not be positive, but some birds, such as Common Crane, are reported to habituate quite rapidly to scaring features such as scarecrows. This potential impact should be mitigated as a matter of principle - the precautionary principle[76].

Mitigation options:

- Use blasting blankets to minimise blasting noise (standard best practice for safety reasons).
- Use directional security lights that minimise casting light outwards or upwards (to reduce night-time disorientation of night-flying birds).
- Identify sensitive habitats (specifically, riverine and lakeshore wetlands) and ensure that workers do not enter these for any reason.
- Establish a ban on the purchase of wildlife products (e.g. skins, feathers) by all members of staff and workforce.

Residual significance: low adverse in short term (not fully mitigable); nil adverse in long term.

5.3.4 Socio-economy

5.3.4.1 Loss of Physical Cultural Heritage

Impact C13: the project involves earthworks and temporary and permanent land take in an area with a significant level of known physical cultural heritage, and the possibility of unknown heritage (archaeological remains such as stone tools made by Early Man). Construction activities could physically destroy artefacts or change conditions so that artefacts are affected by, e.g., changed hydrological conditions, or by improved access and therefore risk of vandalism and theft.

Analysis: a reconnaissance heritage survey has determined that the project area is characterised by a number of types of physical cultural heritage - churches, graveyards, a major mediaeval battlefield, pottery shards of unknown origin, one known rock shelter used by Early Man (on Chehaldibi Hill), sites with concentrations of stone tool debris, and rock excavations of unknown use and age (see Section 4.4.11 and Annex 9). Some of these sites are within the command area and some are close to it, but the exact location, extent and heritage value of all physical cultural heritage features remains to be determined. The irrigation, drainage and service road layout has been arranged so as to avoid known features such as church compounds (although it will take 0.72 ha of land belonging to Acera Mariam Church, and a secondary canal is routed very close to the base of Chehaldibi Hill). A hill near the site of the pumping station and headworks shows evidence of use by Early Man (scattered stone tool debris on surface) as do several prominent hills on the edge of and within the PCA (in particular Narna hill and Chehaldibi Hill). At present these hills have not been identified as potential sources of borrow material or rock (see 5.3.2.3). The main canal is aligned along the interface between dry, sloping land and wetland, a type of environment favoured by prehistoric hunter-gatherers but which has not been surveyed for heritage value. The project clearly triggers OP 4.11 Physical Cultural Resources.

On the basis of the ESIA team's preliminary findings, the authority responsible for heritage within Ethiopia, ARCCH, has proposed carrying out its own "official" survey to confirm the presence and importance of physical heritage features in the project area and to act as the basis for identify appropriate further measures (see Annex 12.2). This survey requires funding.

Temporary and permanent earthworks and construction destroy archaeological and other heritage features within their footprint. The location of the temporary access roads and all borrow pits and quarries to be used is not known, yet.

[76] The precautionary principle: when the consequences of an action are uncertain, take measures to minimise potential harm, even though this may not occur.

Mitigation options:

To avoid negative impacts and to comply with Bank policy, a limited ground-based cultural heritage investigation should be undertaken prior to physical construction. This could be done by providing funds to the ARCCH, perhaps under a flow-through mechanism in the construction supervision contract (note: this item has been included in the ToR for the Management Services Contract). Further action will depend on the findings of the official ARCCH survey, but should include, as routine, the actions listed below:

- Attach a qualified and experienced archaeologist to the construction supervision team during earthworks in sensitive locations (to be identified by the ARCCH survey). The regional Bureau of Culture, Tourism and Parks Development (BoCTPD) can provide appropriate staff.
- Train equipment operators in artefact recognition.
- Include clear chance find procedures in the tender documents.
- Avoid all development (access, borrow pits, quarries) at Narna Hill, Kurtiye Hill, Chehaldibi Hill, Abba Taje Hill (for locations see Reconnaissance Physical Cultural Heritage Survey report at Annex 9).
- Obtain formal heritage clearance from the responsible authority (BoCTPD) prior to any development of access roads, borrow pits and quarries.
- Through the contractor's Community Relations Officer, keep local religious authorities fully informed of construction plans and activities in the vicinity of churches.
- Include the regional, zonal and woreda Culture, Tourism and Parks Development offices on the respective Project Implementation Teams (PITs).

Note: the Terms of Reference for preparation of the Resettlement Action Plans for the Megech and Ribb projects include the task "Determine the impact on cultural property and prepare a plan for relocation and restoration in consultation with local groups". Therefore it is important to coordinate these recommendations with any relevant measures in the final RAP report in relation to further development of the projects' heritage management approach.

Residual significance: nil negative (assuming these actions are undertaken).

5.3.4.2 Rapid Change due to Land Reallocation and Civil Works

Impact C14: construction will be a major civil engineering exercise with a direct impact on some 11,000 people in the command area. "Strangers" will arrive, temporary jobs will be created, land will be reallocated, construction will take land and disrupt existing access patterns, and the entire agricultural system including its livestock components forced to make dramatic adjustments. These changes may overwhelm local coping mechanisms and may generate social resistance.

Analysis: these rapid and major changes will affect an extremely poor, illiterate and unhealthy agrarian society with little social capital, suspicion of government and outsiders, and rigid cultural traditions dominated by the male priesthood. People are averse to signing documents since they consider these may be worthless or subsequently used against them. MPIDP consultations with farmers in 2008 found significant resistance to the reorganisation of land if it involves land consolidation, since farmers might not receive land of equivalent quality and production risks would increase[77]. This fear is partly based on adverse experience with land expropriation for the Wawa Horticultural Farm on the west side of the PCA and also for the *Kuam* project, a 120 ha irrigated farm in Aberjeha Kebele between the Dirma and Kirsit Rivers which is reportedly operated by an outsider.

Consultations by the ESIA study team with focus groups and individuals in the PCA indicated that as of April 2010 local residents still had little understanding of the MPIDP land reallocation process and associated compensation measures, with many misperceptions. Subsequent intensive social preparation at kebele level by the RAP study team is understood to have answered many of these questions and improved local understanding of the land acquisition, compensation and redistribution process (SMEC 2010). Nevertheless, to avoid (a) social resistance, (b) impoverishment due to disruption of existing fragile production systems and livelihoods, and (c) gender-based impacts resulting in impoverishment, it will be necessary to maintain a high level of information dissemination on what is planned, when and where it will happen, compensation procedures, available support measures, and grievance mechanisms.

Mitigation options:

- Intensive social preparation at both kebele and household level, in preparation for land acquisition and redistribution, construction, and agricultural system transformation. Full transparency is necessary. This process is understood to be under implementation as part of the project's RAP.

[77] As reported in the MPIDP Feasibility Study.

- Implement all WUA formation and land redistribution in advance of construction, to give time for farmers to adjust to their new plots and organisations (see also Impacts C16, C18 and O2).
- Provide advance notice to affected kebeles and households prior to any construction activity which will affect them.

Residual significance: nil adverse if mitigation is effective (this will be challenging), with potential for highly positive (in terms of transforming people's perception of government and "development").

5.3.4.3 Permanent Loss of Land, Buildings and Other Assets

Impact C15: the project's infrastructure - canals, drains, roads and flood dykes - will have a significant footprint, occupying an estimated 308.8 ha in total or about 7.5% of the command area. This will reduce the available cropland in the area by some 187 ha and grazing land by 30 ha[78]. It will also require the acquisition of 90 houses, 34 other homestead structures (animal sheds, kitchens, grain stores, wells), a kebele-operated satellite school, 3 wells and 26,416 trees.

Analysis:

(a) Because of the small size and fragmentation of land holdings (about 1.1 ha stated by local informants to be, typically, in some 6 plots)[79], virtually all households in the PCA will be directly affected by land loss to some extent (13.5% in total of 5,554 affected land parcels which, together, total 226.9 ha; this is just over half the total of 10,580 parcels in the 5,141 ha command area). Of this, 187.1 ha is farmland (cultivated), 38.6 ha is woodlots, 0.7 ha is private grazing land, and 0.3 ha with buildings. No additional farmland is available for distribution to affected families unless allocated from communal land or land in government ownership, so mitigation of land losses will need to consider proportionate re-adjustment of all land holdings; this will reduce the average holding size within the command area to about 1.0 ha (see Impacts C14 and C16 for implications). It is understood that Dembia Woreda intends to convert some communal grazing lands to farmland to substitute for land losses (SMEC 2010). Either way, such an exercise will be complex and socially challenging. The lost crop production from acquired farmland will be outweighed by the increase in production on the remaining land as a result of irrigation, drainage, flood protection, double cropping, and agricultural intensification.

(b) Despite sensitive planning, the project's layout necessitates the destruction of 90 homes belonging to 88 households, together with 34 associated homestead-related structures (kitchens, animal sheds, grain stores, 2 hand dug wells). 48 of the houses have corrugated iron roofs, the rest are roofed with traditional materials. The affected households will need to be re-housed elsewhere on their land or nearby (unless they choose to relocate or to leave the area).

(c) Communities will lose 81.9 ha of common land of which 29.7 ha is used for communal grazing, an informal school, and 3 hand dug wells. Achera Mariam Church will lose 0.72 ha of land. The lost grazing land is 7.6% of the total in the command area and is mostly in Aberjeha Dhena Kebele along the line of the Main Canal (17.35 ha); loss of this land is significant at a local scale with possible gender-biased impacts due to the importance of livestock for women (SMEC 2010). The loss of communal grazing land will be compounded by Dembia Woreda's instruction that part of the grazing land in the woreda should be converted to farmland to be allocated to farmers losing land for infrastructure (SMEC 2010). The affected Satellite School provides informal literacy services, was established by the community and is managed by Seraba Dabelo Kebele. The 3 affected community wells (2 in Seraba Dabelo Kebele and 1 in Guramba Bata Kebele) are maintained by the Woreda.

(d) Some 26,416 trees will have to be cut to make way for the project's infrastructure. Of this total 75% (19,854) are eucalyptus, 21% (5,594) indigenous species, and the remainder (4%; 968) various types of fruit tree (virtually all either mango, orange or coffee). This will have a significant impact on both the affected households (loss of fuelwood and construction materials supply, and fruits) and remaining habitat diversity, important for birds which are also pest control agents.

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[78] Data from draft RAP, August 2010.

[79] This information is not consistent with the official registration which gives an average parcel size of 0.49 ha, but can be explained by unofficial local fragmentation and user arrangements.

The project clearly triggers OP 4.12 Involuntary Resettlement, and a full RAP is being prepared by a separate consultant[80].

Mitigation options:

(a) Households permanently losing land, crops, trees and other assets to the project will require:

- Compensation for standing crops and trees and any other improvements or assets on the land. Proposals for crop and tree compensation are presented in the project's RAP, specifically in its Entitlement Framework.
- Fair compensation to non-landowners whose assets are affected, i.e. persons with houses or trees on land legally registered in someone else's name. The RAP includes a form by which the legal landowner can confirm that compensation payment should be made to someone else.
- Provision of replacement land of equal quality nearby, combined with proportionate adjustment of all land holdings in the PCA (see Impact C16). Note: the RAP proposes that if substitute land is not provided, the affected farmer should receive an income allowance for 10 years based on his/her preceding 5-year average income.
- Measures to ensure no loss of income or livelihoods during the transition period to the new system (see Impact C18).

(b) Households losing structures will require:

- Replacement housing and residential land, or cash compensation sufficient to enable the affected household to rebuild better structures on their new or remaining land, together with cash assistance for relocating, a transition allowance, and social services (see Impact O39). Housing compensation and resettlement proposals are made in the project's RAP, and include efforts to ensure that resettlement takes place within the same kebele to minimise social disruption.

(c) Communities losing land and assets will require:

- Cash compensation to the affected kebele.
- Replacing the lost water wells, and upgrading the lost Satellite School in Seraba Dabelo to a Primary School.
- Support for transformation of the livestock husbandry system, with special attention paid to impacts on women (see Impacts O24, O25 and O28).

(d) Loss of trees will require:

- Cash compensation to the affected household and/or kebele.
- Support for fuelwood and other plantations (see Impact O26).

Residual significance: low adverse in the long term (due to permanent loss of productive land), assuming agricultural intensification is successful and sustainable.

5.3.4.4 Redistribution and Consolidation of Agricultural Land

Impact C16: the design of the irrigation system is based on standard farm-level irrigation units of 2 ha (200 m long downslope and 100 m wide across the slope). Each 2 ha unit will be sub-divided into 8 independent plots of 0.25 ha. Since at present households have, on average, 6 plots totalling 1.07 ha, and some 7.5% of the total land in the PCA will be taken up by irrigation and road infrastructure (see Impact C15), this implies 100% reorganisation of existing land holdings and a reduction of the average number of plots to 4 or less per household (depending on the approach taken).

Analysis: following the 2005 land allocation exercise, at present each household has about 6 plots of land of varying quality, some of which are, on average, used for grazing. This will be reduced to (usually) 4 standardised plots of 0.25 ha, each 100 m long across the slope and 25 m wide. Female-headed households are at particular risk during any land reallocation process due to their marginal position in society. This is a highly sensitive topic and will require time, resources, technical knowledge and a high level of local participation to resolve. It is also closely linked to disruption of the existing agricultural system (see Impact C18).

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80 A draft RAP was completed in August 2010 (SMEC 2010).

Procedures and mechanisms for land redistribution for "modern irrigation" are established by the relevant federal and regional legislation and the regional guideline (see 3.3.2.2). Under this process farmers losing land are allocated replacement land through a proportional adjustment of all the irrigation beneficiaries' land holdings, at the same time as consolidation of fragmented holdings to enable effective scheme management. It is understood that Dembia Woreda intends to convert some communal grazing land to farmland to make up for loss of land to infrastructure (SMEC 2010). This will affect livestock owners, especially women, and put increasing pressure on remaining areas of communal grazing and on wetlands. It is clear that land redistribution as well as land loss triggers OP 4.12 Involuntary Resettlement[81].

Land redistribution provides an opportunity to allocate land to some of the many landless young, although this would reduce the overall land area available to each household and would be difficult to administer for reasons of equity (in the case of inadequate land for all landless households). It is understood that land was allocated to the landless on the Koga Irrigation Project and has been recommended (following community consultation) for the Megech Pump (Robit) Project. In both cases the area per household is very small, less than 0.25 ha.

The land redistribution process is administered and implemented at woreda level through the concerned environmental protection and land administration office under the regional authority of the BoEPLAU. It involves the establishment of three committees, namely (i) a Modern Irrigation Land Redistribution Committee (both at kebele level and a "Grand Committee" covering more than one kebele), (ii) a Property Valuation and Compensation Committee, and (iii) a Committee for Compliance Enquiry and Monitoring (also termed a Compensation and Grievances Committee). The process is intended to be fair, transparent and participatory, and beneficiaries are supposed to have some influence on the selection of members of the Land Redistribution Committee and in the amount of land to be taken from each landholder for the adjustment.

The ToR for the Management Services Contract require the PSP contractor to "… provide advisers, during the 3 year construction period, to assist in facilitating the land allocation process. Working with regional authorities, and their advisers, the PSP Contractor will give support and advice to WUAs and farmers on practical issues of land re-allocation and plot construction related to irrigation management during the scheme construction process. This is in addition to any separate staff on-farm activities under the supervision activity, and is provided particularly in relation to the physical realignment of plots to meet the Irrigation Project Infrastructure." Details of this process are to be established following the recommendations in the RAP.

A description of the formal land redistribution procedures is given in the project's RAP (SMEC 2010). The focus of the draft RAP[82] is very much on the land acquisition, compensation and resettlement aspects of the scheme rather than on land redistribution and consolidation and all the associated socio-economic impacts (land redistribution is not listed in the draft RAP's table of "key socio-economic impacts"). Since the two aspects (land loss and land redistribution) are indivisible in administrative, cultural and economic terms, it would be appropriate to consider them together.

The administrative machinery at all levels in the region requires significant strengthening to enable it to implement the necessary land acquisition, compensation, resettlement, land redistribution and support measures.

Mitigation options:

- Ensure that the final plans for the RAP implementation process and associated training, support and capacity building include a comprehensive set of procedures covering the land redistribution exercise as well as the land acquisition, compensation, and resettlement exercise and the associated social support measures.
- Prioritise gender issues in land reallocation to ensure fair treatment of female-headed households, including their full participation in the development of reallocation strategies and procedures and on-the-ground reorganisation of plots.
- Ensure that consideration is given to the issue of plots for the landless in determining the land redistribution strategy.
- Ensure that final plot allocations reflect locally-perceived pre-existing soil types.

Residual significance: nil adverse, subject to effective mitigation which will be challenging.

81 Specifically under OP 4.12 para 3 (a): loss of access to assets, and loss of income sources or means of livelihood.

82 This refers to the draft RAP dated August 2010. The final version was not available at the time of finalisation of this ESIA.

5.3.4.5 Village Irrigation and Reorganisation

Impact C17: the proposed irrigation and drainage layout includes existing settlements which cover some 10% of the irrigable area and are built on some of the better-drained soils. The scheme development concept is that all irrigable land should be irrigated and drained, therefore that irrigation and drainage channels should be constructed through and within settlements, and possibly that homestead boundaries within settlements should be adjusted to maximise irrigation opportunities.

Analysis: the existing settlements are low density, typically comprising a number (up to 100 or more) of family houses of mud and eucalyptus pole construction within small plots of land, often clustered around or near a church, and with eucalyptus trees nearby. The feasibility level irrigation and drainage layout runs both canals and drains through the settlements, generally along homestead boundaries between the houses. Development of irrigation and drainage within settlements is associated with a number of social and operational challenges. These include (i) land take (permanent loss of land to the channels); (ii) interrupted access within the settlement; (iii) the issue of channel maintenance: who will be responsible, and how will it be achieved?; (iv) safety, especially for small children: at present labour demands on women are such that small children are sometimes left unattended or in the care of slightly older siblings; the presence of water-filled channels immediately next to houses will inevitably result in drownings from time to time; (v) health: (a) the channels will provide habitat for mosquitoes in the dry season, and hence assist in maintaining high levels of malaria vectors close to housing; (b) the channels will provide habitat for snails, and hence contribute to high levels of schistosomiasis especially in children; (c) defecation may occur in the channels, so that they will be sources of a range of communicable diseases, especially for children likely to be playing in the water; (d) the channels are likely to be used for the disposal of wastes of various sorts, again creating a health hazard; and (e) in the absence of other water sources in the dry season, the irrigation channels are likely to be used for domestic water supply, with attendant health risks; and (vi) land reorganisation within the settlements if maximum advantage is to be taken of the irrigation water supply for cropping, as opposed to homestead gardening.

Mitigation options: mitigation measures identified to date are:

- Revise the project concept so as to omit settlements from the irrigation and drainage layout (as proposed for the adjacent Megech Pump (Robit) Project (Halcrow-GIRD 2010)), or:
- Retain settlements in the irrigation development concept, but revise the irrigation water delivery concept so as to minimise the hazards identified in the analysis. This would require some type of reticulated (piped) system, with attendant costs and power and maintenance issues, or:
- Reconstruct the settlements at higher density and a much higher standard of housing and of community infrastructure (at present there is, essentially, none), and irrigate the land freed up.

Of these, the first appears to be the simplest, lowest cost, and least socially risky. Domestic water supplies for PCA settlements need major improvement in any case, and some of this water could be used for homestead gardens.

Residual significance: high adverse if not mitigated, specifically for reasons of health and safety; nil adverse if mitigated as recommended (omit settlements from layout).

5.3.4.6 Disruption of Existing Agriculture

Impact C18: land acquisition, redistribution and consolidation will immediately disrupt household cropping practices since from one day to the next each household will control physically different areas of land. Crops on the old land may have to be harvested early, before maturity, or not planted at all. The new land may not be ready for cropping immediately because of timing, lack of water, or the need for land preparation including levelling, boundaries and drains. The project design assumes that the new WUAs will design and construct the necessary field ditches and field drains, and that farmers will themselves be responsible for the precise land levelling which is necessary for effective water management in irrigated vertisols. The new land will also need to be ridged, which is labour intensive if done manually or will require ox-drawn and/or mechanised ridging implements which are not currently in use or available locally. In addition extra labour will be needed for preparation of the new land, patterns of access will be changed (see Impact C19), livestock will require additional herding to prevent them straying into new, irrigated crops, and communal grazing areas will be lost to infrastructure and by conversion to farmland, increasing the difficulties of finding fodder and grazing for livestock.

Analysis: the existing agricultural system is based on risk aversion: farming households have very little cash and few resources; crops, crop varieties and cropping patterns are chosen to ensure, at least, subsistence needs in terms of cereals based on the traditional staple diet (principally teff and sorghum). Livestock are kept principally for draught power, dung (for fuel), and as a bank account. Cash-earning enterprises (e.g. cash crops) are more risky and tend to require additional surplus labour and/or cash, which are in short supply in the household-based economies prevalent in the command area. Construction of the project will result in immediate and ongoing disruption of this system with increased risks and labour demands on already stressed farming households. Women's burdens are likely to increase further (if that is possible) and children may be taken out of school for herding duties. This impact is closely related to Impact C12 - Rapid Change - and the need to adjust to radically new conditions.

Mitigation options:

- Implement land acquisition and land redistribution in advance of construction, so that farmers have some time to adjust to their new plots before the additional stress of physical construction.
- Accelerate establishment of WUAs so that their members and leaders can be fully involved in the transition process (see also Impact O36).
- (i) expand the formal kebele-level vulnerable households lists to include all vulnerable households within the PCA, not just those directly affected by loss of assets; (ii) combine this with establishing and maintaining a database of such individuals and their families (recommended in the RAP); (iii) expand the support for Vulnerable Groups included in the RAP to cover all the vulnerable households in the PCA, with particular attention paid to impacts on women. Note: this expansion is unlikely to be a large number since nearly all households in the PCA will be affected by land loss and therefore have already been included in official lists.
- Phase implementation of the project, so that lessons can be learned and institutional capacity developed (it is understood that construction will commence on the west side of the Dirma River, with physical project roll-out to the east side of the river in Year 2: see Table 2-4 for subsequent irrigation uptake assumptions).

Residual significance: very high adverse in short term (disruption and risk to poorest households), nil adverse in longer term of project is successful and sustainable.

5.3.4.7 Disruption of Access

Impact C19: the project involves constructing some 565 km of main channels plus several thousand field ditches and drains each about 200 m long. The canals will be kept full of water throughout the year to minimise seepage losses (by ensuring the vertisols are kept fully expanded) and the drains will be partly full of water. Except for the field drains, all these channels will be sufficiently wide to represent a barrier to walking (~1m or more at water surface).

Analysis: the design provides for 3 road bridges and four pedestrian/livestock bridges on the main canal (21 km); in addition both the connecting roads (see Section 5.4.8.6) will join the service road on the right bank of the main canal after crossing it at Km 0+880 and Km 20+500, respectively. Four footbridges (1.50m wide) will be constructed at the four cross-regulators on the main canal, at Km 5+280, 10+180, 14+430 and 18+570.

The design also provides for 41 concrete slab or concrete pipe crossings on the secondary canals and sub-secondary canals (60 km), but none on the remaining 484 km of irrigation channels (Figure 5-1).

Initially, the new channels will severely disrupt existing patterns of access for local residents who do not wish to jump across them or wade through the water (with associated exposure to schistosomes - see Section 5.4.9.2). Livestock will simply walk through and across the channels, causing trampling damage to the banks. Residents may construct informal bridges with associated hydraulic performance, channel maintenance and human safety issues (Photo 5-2).

Mitigation options:

- Construct additional bridges and crossings as their need becomes apparent.

Note: as a specific task during construction, the supervision consultant (PSP contractor) could liaise with kebeles to identify optimal crossing points and crossing types (mainly for pedestrians and livestock). These could then be built by the construction contractor as day works or at unit rates.

Residual significance: initially medium negative, subsequently nil (as social patterns adapt).

Photo 5-2: Informal bridge over new canal in Koga Irrigation Project

5.3.4.8 Employment of Outsiders

Impact C20: the project will require labour for construction. Work may be taken by "outsiders" rather than local residents, creating tensions and missing opportunities for mitigation of disruption to local lifestyles due to project implementation.

Analysis: the population is poor and resources are scarce. Therefore, although construction wages are not high, the temporary employment opportunities offered by the project will be significant and competition is likely to be intense. "Outsiders" are likely to be attracted to the area in search of work.

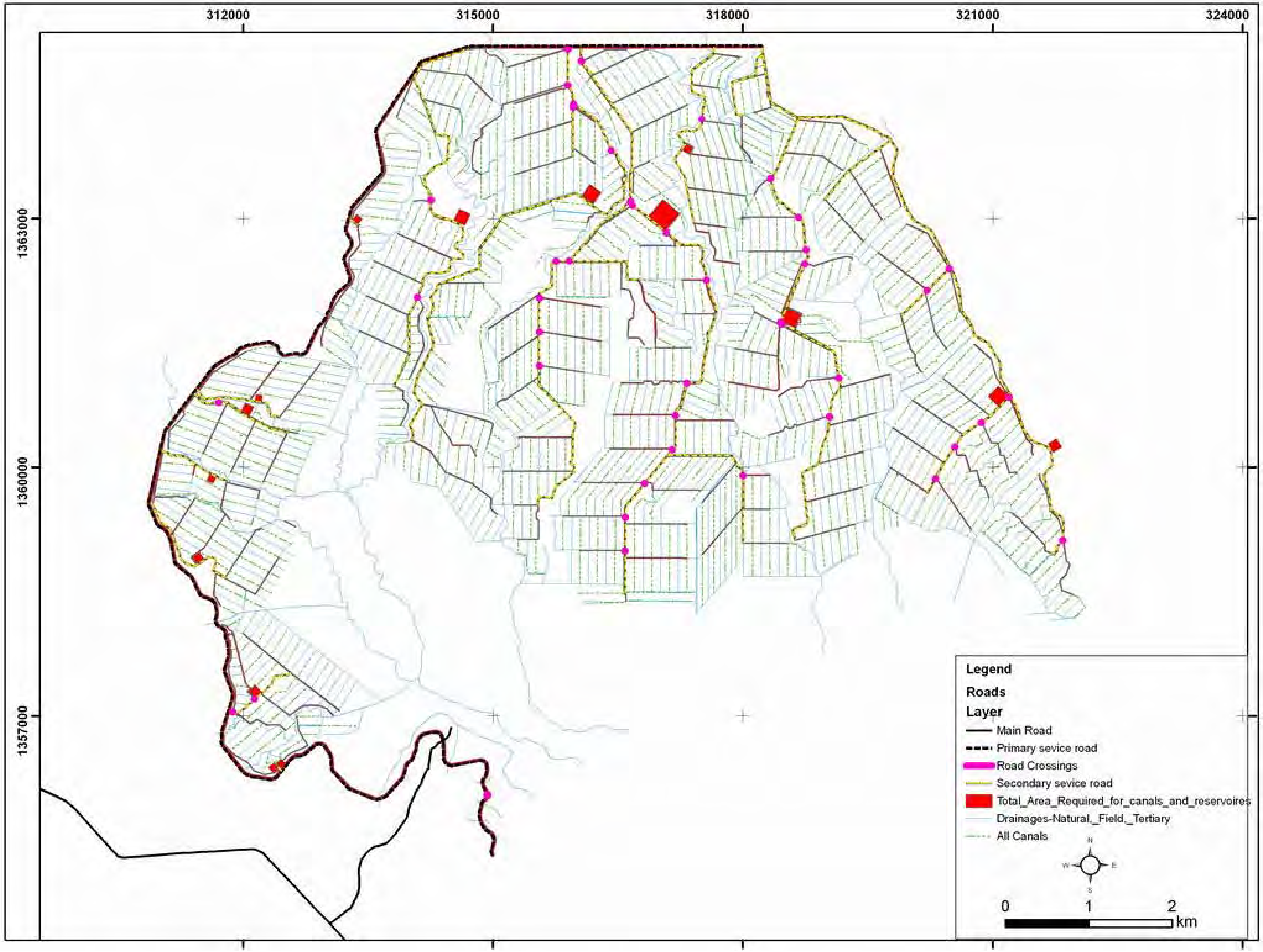
The FS does not contain information on construction planning, so the probable size and skills of the workforce are unknown at this stage. The project involves a large volume of earthworks, but much of this has to be carried out with considerable accuracy and therefore is likely to be machine-intensive rather than labour intensive. However, there will still be a large unskilled labour requirement.

Mitigation options: recruitment policies will need to consider social issues and project acceptability. Considering the high local impact of the project in terms of land and disruption of existing lifestyles, together with the distrust of "outsiders", it is probably wise to maximise local employment. Local residents are looking forward to construction-related employment opportunities, especially women and landless youth. Local benefits would be maximised and some of the negative impacts of construction mitigated if local residents, especially the most severely project-affected people (PAPs), are given priority for recruitment. This will require:

- Social preparation and the incorporation of eligibility for priority in employment into the RAP Entitlement Matrix, together with an official mechanism for providing names to the construction contractor and for follow-up to track the numbers of PAPs employed.
- The inclusion of appropriate wording in the construction contract.

Residual significance: high, assuming a local / vulnerable group employment policy is implemented.

Figure 5-1: Indicative channel layout, night reservoirs and road crossing points



Source: RAP consultant (SMEC), preliminary information (April 2010)

5.4 OPERATION PHASE

5.4.1 Overview

This section analyses the potential direct and indirect negative impacts of operating the scheme as proposed, together with associated sustainability issues.

Operation phase impacts and issues are listed in Table 5-5, together with a simple indication of their significance before mitigation (none/low, medium, high). The table is followed by discussion and analysis of each impact under the general topic headings of agricultural feasibility, soil and water management, hydrology and water quality, pests and diseases, ecology, social, institutional and economic. These headings are considered to be more useful than a strict division of impacts into physical, biological and social.

Table 5-5: Operation Phase Impacts - Summary

No.	Topic	Potential Impact	Significance*			Mitigation Needed?
			None/ Low	Medium	High	
Agricultural Feasibility						
O1	Agricultural Feasibility	Potential delay in irrigated agriculture development			•	YES
O2	Agricultural Sustainability	Delayed uptake of benefits due to inability to meet on-farm soil & water management needs - labour, equipment and skills			•	YES
Soil & Water Management						
O3	Soil Management	Water use inefficiency			•	YES
O4		Inadequate drainage			•	YES
O5		Groundwater rise and secondary salinisation			•	YES
O6		Decline in soil fertility		•		YES
O7		Impact of vertisols on structures	•			YES
O8	Erosion	Erosion in command area & sedimentation from upstream		•		YES
Hydrology & Water Quality						
O9	Hydrology	Continuing impacts from floods		•		YES
O10		Climate change	•			NO
O11	Water Quality	Pollution from agrochemicals, salinity and waste			•	YES
Pests & Diseases						
O12	Pests & Diseases	Changes in pests and diseases			•	YES
O13	Pesticides	Inadequate pest management and improper use of pesticides			•	YES
Ecology						
O14	Ecology	Habitat degradation			•	YES
O15		Ongoing impacts on globally important birds			•	YES

No.	Topic	Potential Impact	Significance*			Mitigation Needed?
			None/ Low	Medium	High	
O16		Impacts on other wildlife	•			YES
O17		Introduction of invasive species	•			YES
O18		Reduced agrobiodiversity	•			YES
O19		Increased stress on lakeshore zone			•	YES
O20	Fish	Changes in river flows and morphology			•	YES
O21		Fish entrainment at pumping station	•			YES
O22		Impact of water pollution		•		YES
Socio-economy						
O23	Social change	Cultural constraints on social and economic change			•	YES
O24	Gender	Impacts on women			•	YES
O25	Livestock Husbandry	Impacts of transformation of livestock husbandry system			•	YES
O26	Energy	Inadequate fuelwood and energy			•	YES
O27	Access	Changes in local access & barrier effects of new channels Limited external links due to inadequate road maintenance			•	YES
O28	Benefits and Equity	Inequitable distribution of benefits - incomes & employment			•	YES
O29		Price reductions in local markets and associated impacts on rain-fed producers		•		YES
O30	Health	Extended malaria season			•	YES
O31		Increased schistosomiasis			•	YES
O32		Changes in other diseases		•		YES
O33		Impact of continuing poor health on beneficiaries' ability to benefit from project		•		YES
O34		Inadequate water, sanitation and hygiene reducing project benefits			•	YES
O35		Safety hazards	•			YES
Institutional						
O36	On-farm management	Ineffective operation of WUAs			•	YES
O37	Off-farm management	Risks of experimental O&M model			•	YES
O38	Services and inputs for agriculture	Reduced project benefits due to inadequate provision of essential agricultural services & inputs including research, knowledge, credit, crop storage and processing, and links to markets			•	YES

No.	Topic	Potential Impact	Significance*			Mitigation Needed?
			None/ Low	Medium	High	
O39	Social services and infrastructure	Reduced project benefits due to inadequate provision of essential social services, especially health, water and sanitation, also education, road maintenance, electricity and telecommunications			•	YES
Economic						
O40	Markets	Market inelasticity affecting economics of entire project			•	YES
O41	Affordability by farmers	Unaffordable O&M costs			•	YES
O42	Capital and operating costs of scheme	Under-funding of costs of compensation and resettlement, social support, agricultural research, extension services & farmer training, equipment, environmental & social mitigation and monitoring, etc.			•	YES

***** Significance: before mitigation, Consultant's professional opinion; see text for explanation

Source: Consultant

5.4.2 Agricultural Feasibility

5.4.2.1 Potential Delay in Irrigated Agriculture Development

Impact O1: the project relies on a knowledge-, inputs- and labour-intensive model of production at the field and household level. This model is untested under the environmental, social, economic and institutional conditions prevailing in the command area. If the model is not feasible, there will be a delay in project benefits as potential solutions are tested and applied.

Analysis: the goal of the project is to transform a primarily subsistence rural economy into a commercialised economy based on irrigated crop production by smallholders. The existing agricultural system has been in place, with few changes, for several hundred years. It is based on supplying the needs of individual households for staple crops (principally the staple cereal, teff), and includes livestock as a vital component of the system for providing draught power for cultivation, manure for fuel, and as a reserve of cash in times of need. Risk is minimised. This rural way of life is associated with deeply-entrenched cultural and religious traditions. It is also associated with heavy labour demands, especially on women, low returns, low standards of living, and few prospects for upward mobility.

Changing this system to one based on double or triple cropping for both domestic staples and outside markets will require very large adjustments in household lifestyles and practices: new tools will be needed, and new skills; the need for cultivations will increase and therefore the demands on large livestock; labour demands over the year will increase above the existing high levels, with differential impacts on men and women. In addition there will be a need for new institutions, for crop processing and storage facilities, for marketing, and for changes in knowledge, attitudes and behaviour. There is a clear requirement for trials and proof-of-concept at household level and farm level before scaling up to full implementation. This will be necessary in any case, as part of the research required to identify and develop the various extension and inputs packages that will be required (see Impact O2).

Under Component 2 of the ENIDP, ARARI has commenced pilot trials in both the Megech and Ribb command areas (described in ARARI 2010). A list of the ARARI research projects planned for 2010-2011 is attached at Annex 4.3. The ANRS BoARD is establishing Farmer Research and Extension Groups (FREGs) for participatory on-farm research.

The project's economic and financial analysis takes into account a 5 year period to achieve full irrigation development (as opposed to 2 to 3 years for physical construction), and a further 3 years for yields to reach predicted irrigated norms. Challenges along the way might extend the period before yields reach their full potential.

Mitigation options:

- All ENIDP Component 2 activities.
- Ensure that the ARARI trials now being implemented include a "full scale" trial (i.e. at least one basic irrigation unit of 2.0 ha, 8 farmers), over at least one full agricultural year.

Residual significance: depends on the outcome of the trial; if this identifies constraints which can then be overcome by adjustments in project design and operation, then the residual impacts will be very highly positive.

5.4.2.2 Inadequate Skills, Labour and Equipment Requirements at Field Level

Impact O2: the project design assumes that Water Users' Associations (WUAs) will design and build the necessary field ditches (FDs) and field drains, and that farmers themselves will carry out all land preparation (levelling, and then the creation and maintenance of an average of 13.35 km of ridges and furrows per household for dry-season irrigation), together with the husbandry of commercial crops and the maintenance of a proportion of the irrigation and drainage channels. This will require high levels of labour at certain periods and a need for new implements and skills. If these resources are not available, the project benefits will be reduced.

Analysis:

(a) The project will construct all irrigation and drainage infrastructure down to tertiary level, but responsibility for the channels needed to deliver water to the basic irrigation units (BIUs) and to drain them has been delegated to the respective future WUAs. Initially these are unlikely to have the skills, funds or technology to construct the channels to an adequate standard, with consequent risks to project implementation, effectiveness and flow of benefits.

(b) The proposed irrigation system - ridge and furrow, in vertisols, requires extremely precise water handling to ensure effective delivery of water to all parts of each irrigated plot, to avoid excessive water use, and to avoid runoff and in-field erosion. For this the land requires precise levelling (see Table 5-6) to create well-graded fields for furrows (0.2 to 0.4%). This can only be achieved by mechanised means (laser levelling) and must be done prior to the construction of the lower levels of irrigation and drainage channels (tertiary and below). At present this major activity has not been allowed for in the project costs.

The water management itself is a skilled task and will require significant levels of practical farmer training.

(c) The in-field design is based on furrow irrigation, with some 267 furrows each 100 m long in each basic irrigation unit of 2.0 ha. This is equivalent to 3.3 km of furrow per 0.25 ha parcel, or 13.35 km for 4 parcels, the average land holding. Once constructed, these furrows will need accurate maintenance to permit efficient irrigation, using ridging ploughs. Retaining the ridges in the wet season would limit the possibilities for growing staple cereals such as teff, or new ones such as rice, which require a different in-field micro-topography such as broad beds. This implies that the ridges will have to be reconstructed at the beginning of each dry season, and vice versa. This would require significant resources (labour, draught power, and specialised ploughs) in specific time periods, and as yet is not a proven technology in the command area (see above).

(d) The dry season crops will require significant levels of labour input, especially if quality and yields are to be high and pests and weeds controlled. In addition, each farmer, as a WUA member, will be responsible for maintenance of a proportion of the tertiary canals, field canals and field drains required to service the average land holding of 1.0 ha in four separate parcels. The design consultant estimates that the proposed cropping pattern will involve 120 days labour in the wet season per household, plus 192 days for the selected dry season crop basket, total 312 days per year, compared to an assumed labour availability per household of 400 days (2 full labour positions)[83].

The FS labour availability assumptions may be optimistic, given the area's extremely strong cultural traditions with many non-working days (see Table 4-21), plus the existing extreme workloads on women (average 14.2 hours per day), plus the possible need for additional labour inputs for livestock husbandry during the multi-year agricultural system transformation period. Data from the adjacent Megech (Robit) scheme indicate a current labour requirement of 180 - 330 days per ha with only 10-20% of the land irrigated.

It is highly likely that skills, labour and equipment, including draught power, will all be significant limiting factors constraining uptake.

83 TAHAL-CECE responses to World Bank comments, Feb. 2010.

It is difficult to irrigate and manage vertisols: they can only be cultivated within a narrow range of moisture contents (too dry and they are too hard; too wet and they are too slippery). Water will only penetrate the soil via cracks which form when the soils dry out, and conventional models of available water capacity (AWC) for scheduling irrigation are hard to apply. Irrigation needs to be applied in relation to the drying cycle. In the Sudan, optimum irrigation intervals on vertisols may be more than 20 days. It is clear that the 8-day rotation assumed for scheme design is likely to require adjustment; experimentation will be necessary, and this will take a number of years.

Mitigation options:

(a) Challenges of on-farm construction

- Provide technical and logistical support for on-farm construction to the WUAs, either through an addendum to the construction contract or through the O&M Contractor who will also be tasked with providing support for WUA formation.

(b) Land preparation (levelling)

- Precise land levelling should be carried out by the project as a one-off capital investment. This should be done as part of the land redistribution and consolidation exercise, *before* the reallocated parcels are marked out in the field (for efficient use of the levelling machinery).

(c) Resources for ridging

- Consider alternative irrigation methods, specifically basin irrigation, initially.
- Provide significant levels of support for ridging, through farmer training and access to equipment.

(d) High labour demands

- Labour requirements can be reduced, for example by mechanisation, or labour freed up, for example by providing domestic water near houses and by converting to fodder crops and stall-feeding to reduce herding requirements (see Impacts O24, O25, O38).
- Moving from the traditional plough (*maresha*) to other types of cultivation equipment would be a transforming step, but requires household financial resources that do not generally exist at present. A subsidised rental system is likely to be required in the transition period.

(e) Skills requirements

- Skills requirements can be met through a combination of training and demonstrations. In non-literate societies (as in literate ones) seeing is believing: the Farmer Field School (FFS) approach is likely to be an effective mechanism for adaptive research and agricultural extension. In the medium term, literacy will be essential (see Impact O23).

  Note: under ENIDP Component 2 an Action Plan has been developed entitled "Farmer Research and Extension Group - Trialling of Technologies for the Ribb and Megech Irrigation Command Areas". This has as its main objectives: "to verify existing improved crop varieties under irrigated farm conditions in the Ribb and Megech command areas and to trial and select agricultural and irrigation technologies suited to these areas." A further objective is: "to provide extension advice to households currently farming on irrigated land in the vicinity of Lake Tana." (NIRAS 2009). The plan is now under implementation by BoARD and ARARI (see research proposal No. 32 in ARARI (2010), and list of research proposals at Annex 4.3).

Residual significance: high adverse unless practical solutions can be found these major constraints.

5.4.3 Soil & Water Management

5.4.3.1 Inefficient Water Use

Impact O3: the project will use, on average, some 7,600 m^3 of water per ha per year (760 mm).

Analysis: the irrigation technology selected, gravity irrigation using ridges and furrows on the contour, is relatively simple (a major reason for the selection), but is relatively inefficient in terms of water use compared to other irrigation technologies (e.g. sprinklers, drip) which use significantly less water per unit of crop production but have higher capital and operating costs and skills requirements (see Chapter 7). Furrow irrigation can have efficiencies as high as 90% but are more typically 40-70%, with loss of 20-40% due to over-irrigation and furrow-end ponding (Kay 1986).

Inefficient (excess) water applications pose a salinisation risk (see Impacts O4 and O5). Associated issues related to surface irrigation identified in the FS include (i) inexact irrigation, resulting in relatively low yields, (ii) no flexibility in applying smaller water quantities and shorter irrigation intervals, (iii) many hydraulic structures are necessary for road and canal crossings and for flow control (falls, flumes), and (iv) tertiary canals and the extra drainage canals occupy larger areas than would be needed for pressurised irrigation.

The main water-using crop, rice, is proposed for the rainy season (see Table 2-3), although NIRAS (2009) consider that rice will rapidly become the predominant crop in the command area year-round. This would be done in flooded basins rather than. New rice growing methods such as the System of Rice Intensification (SRI) can reduce water (and labour) demands compared to traditional intensive wet rice production systems, at the same time as boosting production

(see http://ciifad.cornell.edu/sri/ for more information).

Mitigation options:

- Trial the System of Rice Intensification to determine its relevance to the command area, and upscale as indicated.
- Convert to alternative irrigation technologies which use less water per unit of yield as soon as economic and skills conditions permit, or as soon as environmental monitoring indicates incipient salinisation.

Residual significance: nil adverse, if scheme success enables farmers to pay O&M fees. If inefficient water use results in groundwater rise and secondary salinisation, this would be a highly adverse outcome.

5.4.3.2 Inadequate Drainage

Impact O4: (a) a large part of the project command area is only marginally suitable for irrigation due to wetness, or is not suitable; (b) there is a need for an intensive drainage system in an area of extremely difficult drainage conditions; (c) drainage of the PCA is affected by lake levels, and the 10-year return period level selected for the drainage design is different from the same level computed by another study; (d) drain performance depends on good maintenance which may not occur in practice.

Analysis:

(a) As stated in the FS, the soil suitability map of the PCA shows that 80% of the project area falls under S2w and S3w categories, which are moderately and marginally suitable for irrigation, respectively, due to wetness. Around 15% of the area, close to Lake Tana, is not suitable for irrigation due to wetness in the present situation, and the remaining 5% of the area is permanently not suitable for irrigation.

(b) The FS also states that poor drainage is the main cause of high salinity observed at lower Megech. The chemistry of the groundwater in the Megech plain (Ca-Mg-SO_4-HCO_3-Cl) suggests that the observed salinity does not originate from a deep source, but from shallow groundwater subject to evaporation. The FS goes on to state that irrigation, unless properly managed, can worsen the existing problem to the extent of creating irreversible damage.

(c) The FS observes that groundwater shallower than 3 m is highly exposed to direct evaporation. Groundwater levels should be kept below at least 3 m to prevent direct evaporation and salt buildup. West of the Dirma River, groundwater is currently at around 2 m below ground level.

(d) The FS design responds by proposing to (i) exclude the most difficult and unsuitable areas from the project, and (ii) to use pressurised irrigation techniques over part of the area to reduce the chance of excess water applications, waterlogging and salinisation. However, pressurised irrigation is regarded as too expensive and complex at this time and a decision has been made to develop the whole area for surface irrigation, at least initially.

(e) The FS design includes an intensive land drainage system designed to remove both drainage return flows and runoff generated by rainfall. The system relies on open drains on the lower side of basic irrigation units, flowing to larger drains and eventually to the main natural drainage channels (MNDC). The MNDC will be enlarged by excavation and dyking to safely discharge the 10-year flood (see Impacts C10, C11).

(f) The FS states that outflow from the drains is affected by lake levels for some 3 km from the lake (but does not provide backwater curves). The 10-year lake level selected for the design of the MNDCs is 1,787.2 m asl, as reported in the SMEC study (2008). Frequency analysis of the lake levels has also been carried out for the flood risk study (Riverside 2010), and for the same return period the level computed is 1,787.72 m asl. The difference between the two 10-year levels is 0.52 m, which is significant considering the very flat landscape. If the MPIDP FS design is too low, the drain outlets will be submerged more often and flooding will be more frequent than designed.

(g) The performance of the drainage system will depend on regular, effective channel maintenance to remove weeds and maintain channel profiles. Conditions for weed growth in channels will be excellent - water, warm temperatures, sunshine and nutrients from fertilised plots - and weed growth will be fast and continuous (Photo 5-3). Vertisols are highly erodible and prone to damage from slumping and from trampling by livestock; the cross-sections of small channels in vertisols will rapidly degrade. Maintenance of on-farm drainage channels and, presumably, the tertiary drains will be the responsibility of WUAs and their members. The total length of these channels will be some 383 km, or nearly 100 m per beneficiary household. Drain maintenance is likely to receive a lower priority in household labour budgets than irrigation water supply and in-field activities. Maintenance of the larger drains and the MNDC will be the responsibility of the O&M contractor. In addition to weeds, these larger channels may be subject to siltation as a result of erosion upstream and/or bank erosion within the PCA, and silt deposition in the drainage channels due to constriction of flows between the new dykes.

Photo 5-3: Weed growth in new channel in Koga Project

Mitigation options:

(a) Soil unsuitability due to wetness

- Exclude the most sensitive areas from the scheme (this has been done).
- Use irrigation technologies which minimise water applications and the risk of waterlogging, such as pressurised (sprinkler) or drip irrigation (these are considered too expensive and complex).
- Convert to alternative irrigation technologies as soon as economic and skills conditions permit, or as soon as environmental monitoring indicates incipient salinisation (see Impact O3).

(b) Requirement for drainage system

- Minimise water applications through farmer training and non-surface irrigation technologies.

(c) Drainage system design levels

- Check the Flood Risk Study findings (Riverside 2010) and review the 10-year lake level selected for drainage system design.

(d) Drain maintenance

- Ensure that drainage receives adequate attention during WUA operation through WUA training and support, including internal enforcement of channel maintenance standards by individual WUA members.
- Ensure that the O&M contractor has to meet high performance standards with respect to drain maintenance.
- Implement watershed management activities upstream (especially on the Dirma River and its tributaries) to reduce sediment inputs to the PCA (see Impact O8).

Residual significance: the performance of the drainage system is key to the sustainability of the project. If it works effectively and can be maintained in perpetuity, then the residual negative effects on soil quality will be nil. However, as pointed out in the FS, under surface irrigation "*project benefits are expected to drop with time because of the development of waterlogging and salinity*". This would be a highly adverse outcome and emphasises the need to move rapidly towards more advanced irrigation technologies.

5.4.3.3 Groundwater Rise and Secondary Salinisation

Impact O5: the soils in the command area are almost all vertisols, clays which expand when wet and become impermeable. The groundwater is saline at shallow depth. Incorrect water management at farm level (due to lack of skills and knowledge) and inadequate drainage (due to poor drain maintenance) could result in a rise in the water table, and consequently secondary salinisation of the topsoil.

Analysis: salinisation is a major hazard to project sustainability: according to the MPIDP FS, "… *excess moisture, an increased EC*[84] *and higher sodium content in soil are negative factors limiting crop yield potential. It is rational to assume that yields will deteriorate with gravity irrigation in unsuitably drained areas and that this process will begin shortly after the onset of surface irrigation*." The FS goes on to state that "… *for parts of the PCA gravity irrigation will probably have medium- and long-range negative effects on farming. Application of gravity irrigation in these particular areas will probably destroy the soil and will gradually damage the agronomic performance of both the dry season and rainfed farming systems*." The solution offered is "… *The only way to avoid soil salinisation combined with sodium content increase under the command area conditions is to prevent irrigation water penetrating to deep soil layers. Applying an optimal amount of water by using pressurized irrigation together with effective drainage is the best way to achieve this goal*."

The pros and cons of gravity and pressurised irrigation in the PCA, and also rainfed farming, are summarised in Table 5-6.

Table 5-6: Comparative Analysis of Rainfed, Gravity and Pressurised Irrigation Methods in PCA

Factor	Rainfed Farming	Gravity Irrigation	Pressurised Irrigation
Salinisation hazard	nil	very high	low
ESP (sodium) level	nil	very high	low
Drainage need	high	extremely high	high
Land levelling	no need	crucial	no need
Crop yield potential	100%	150% during initial years, descending to below 100% gradually if drainage not managed appropriately	200%
Skilled operators	no need	basic	important
System maintenance	---	intensive	simple
System price	---	low	high

Source: MPIDP FS, 2010

The soils of the PCA are vertisols (black cotton soils) which are characterised by a high montmorillonite clay content and typically develop on calcareous materials. Calcium carbonate concretions can be observed on the surface of the soils in places in the PCA and calcareous materials are visible in the sides of gullies. Salinisation due to these types of non-sodic salts is generally easier to manage than salinisation involving salts dominated by sodium. For example, acidifying fertilisers such as DAP or urea and manure including green manure can convert carbonates to soluble forms which can be leached away.

Management of sodic secondary salinisation in vertisols is more difficult: salts tend to accumulate on the faces of the soil peds formed by cracking; these salts need to be washed down (below rooting depth) or away (off the field). Since vertisols do not drain vertically, the salts must be flushed away by surface application of excess water, ideally after the main rains and a period of drying, allowing cracking. If drainage is inadequate (see Impact O4) or water control inefficient, this control measure may not be effective or feasible.

84 EC: Electrical Conductivity, a measure of the concentration of salts.

Mitigation options:

- Include soil and water monitoring in the proposed full-scale farm-level trial (see Impact O1).
- Ensure farmers and WUAs have the knowledge and skills necessary to minimise surplus water applications (see Impact O2).
- Establish water fees based on volumetric measurement rather than area; this requires measurement technology and organisations.
- Enforce high levels of drain maintenance both on and off-farm.
- Switch to other irrigation technologies.
- In the case of non-sodic salinisation, increase the application of acidifying fertilisers and manures and attempt leaching by excess surface irrigation.

Note: soil water levels and salinity will require very close monitoring to provide early warning of problems. This is not a mitigation measure, but is an essential monitoring measure for the Megech project (see Chapter 8, ESMP).

Residual significance: potentially highly adverse if the mitigation measures identified are not fully implemented or are ineffective.

5.4.3.4 Decline in Soil Fertility

Impact O6: intensified cropping may result in a decline in soil fertility.

Analysis: the dominant soils in the command area are vertisols with a generally adequate level of P and K but inadequate N and organic carbon (C). At present fertility is maintained by silt from annual flooding and by a generally low level of off-take of crops (low yields, single cropping). Organic and inorganic fertilisers are not in general use. Flood control will stop this form of natural soil amendment. N will be required on a regular basis, and organic matter will be needed to maintain and improve soil structure. This could be in the form of manure (currently collected and used for fuel rather than as fertiliser) or crop residues (if not fed to livestock).

Mitigation options:

- Provide easy access to inorganic fertilisers (see Impact O38).
- Improve the fuelwood supply, so that manure is no longer needed for fuel (see Impact O26).

Residual significance: nil, if effectively mitigated.

5.4.3.5 Effect of Vertisols on Structures

Impact O7: the dominant soils in the command area are vertisols which crack when dry (Photo 4-3) and swell when wet. Structures built on and in these soils could be affected by heave.

Analysis: in vertisol areas masonry structures (e.g. flumes on smaller channels) are at risk of cracking due to soil shrinking and swelling and the resulting differential heave and subsidence.

Mitigation options:

- Design all structures, down to field level, to resist damage due to soil heave (by, e.g., using unitary construction, avoiding masonry, installing foundation platforms).

Residual significance: low adverse (not fully mitigable for all structures in long term).

5.4.3.6 Erosion in Command Area & Sedimentation from Upstream

Impact O8: vertisols are highly erodible, even on gentle slopes as in the command area. Gullying is possible and could threaten the new infrastructure. The catchments adjacent to the command area (principally the Dirma and its tributaries) are in poor condition, widely cultivated and heavily grazed (Photo 4-17), with low productivity and significant surface and other forms of erosion (Photo 4-11). Sediment originating in these catchments will continue to affect watercourses downstream unless watershed conditions are improved.

Analysis:

(a) Despite the generally very low slope angles, the vertisols in the command area are prone to erosion (Photo 4-11) which can rapidly become severe if runoff is concentrated. In vertisols, water passing outside hydraulic structures or seeping around them can rapidly create rills and tunnels and affect their stability. Livestock will trample and damage irrigation and drainage channel banks. ARARI is trialling the use of forage grasses to protect channel banks in the Koga Project, with associated user groups.

(b) High population and grazing pressures and cultivation of all available land, including on slopes, have completely altered watershed conditions over most of the Lake Tana basin. The catchments of the rivers crossing the PCA are no exception. As a result, surface erosion is widespread, with significant volumes of sediment being moved downstream. Most of this geomorphological work occurs during and immediately after heavy rains near the beginning of the wet season, when vegetation cover is sparse but soils have been wetted by antecedent rainfall (see Birru (2007) for review). Soil loss estimates for cultivated land in Ethiopia's north-west highlands are very high: 131 to 170 t/ha/yr (Herweg & Stillhardt 1999). Limited data are available on sediment transport by rivers in the region; the MPIDP FS reports EPLAUA figures for sediment load estimates for the major rivers entering the lake as follows: Gilgel Abbay: 1.70 t/km2/yr; Gumera: 1.39 t/km2/yr; Ribb: 0.07 t/km2/yr; and Megech 0.58 t/km2/yr. These values are extremely low compared to the volumes mobilised upstream, especially for the Ribb River, and reflect the very high levels of sediment deposition in the large floodplains surrounding the lake. Birru (2007) reports an MoWE figure for the sediment yield of the whole Lake Tana basin (measured in the Blue Nile leaving Lake Tana) of 0.13 t/ha/yr.

Whatever the values, local residents in the Dembia Plain are fully aware of the value of the sediment when spread in a thin layer over the land during the annual floods. The significance of ongoing and possible intensifying upstream erosion for the project will be principally (i) the deposition of sediment in the main natural drainage channels, (ii) the costs of channel maintenance, (iii) the practical issue of where to deposit the material excavated, and (iv) the possibility of enhanced sediment delivery to the lake due to channelisation and dyking.

Mitigation options:

(a) Erosion within command area

- Vegetate all unlined channel sideslopes, berms, banks and any other exposed soil surface using non-invasive grasses. This should be done during construction, as part of the construction contract, with subsequent maintenance by the O&M contractor using local staff responsible for specific, short reaches of the channels.
- Trial the use of vetiver grass for bank stabilisation and erosion control in the command area, and promote if successful.

(b) Sediment input from upstream

- Consider extending successful practices piloted by ongoing land management projects (TBIWRDP, SLMP and Productive Safety Net - public works sub-component) to the watersheds above the Megech command area, specifically the Dirma and its right bank (western) tributaries.
- Ensure that drain maintenance is adequate to maintain hydraulic performance of the main natural drainage channels (see Impacts O4 and O9).

Residual significance: nil adverse, if mitigated effectively, and moderately positive, if watershed condition eventually improves sufficiently to have measurable impacts on sediment mobilisation and transport.

5.4.4 Hydrology and Water Quality

5.4.4.1 Continuing Impacts from Floods

Impact O9: parts of the PCA will be flooded by channel discharges with a 5 or 10-year return period; this could cause important crop losses and physical damage to channels by siltation or erosion.

Analysis: Section 5.4.3.2 already deals with the drainage aspects of flood protection. Another aspect consists of preventing floodwaters from entering into the irrigation system with the use of flood protection bunds, interceptor drains and/or other purpose-built channels. Considering the large catchment areas of the Dirma and Nededit rivers and their considerable discharges, which are responsible for flooding in the PCA, the MPIDP proposes to enlarge the natural watercourses crossing the command area to cope with a 10-year discharge (except for the Nededit, which will be diverted above the command area to the old course of the Megech River by the Megech Gravity irrigation project). This should protect the irrigation infrastructure and agricultural fields from flood damage. Other main drainage channels will be designed for discharge of a 5-year return period. The road crossings on these rivers will be designed for discharges corresponding to a 25-year return period.

Clearly, parts of the PCA will be flooded by channels discharging flows higher than the 5-year return period, and other parts when flows exceed the 10-year discharge. This could cause crop losses if farmers have adjusted to non-flooding conditions, and could also lead to physical damage if the floods are severe or if the irrigation scheme management is not well adapted. For instance, there is a potential risk of siltation of canals and other structures, and a risk of secondary salinisation as a consequence of groundwater rise if floodwaters cannot drain.

Mitigation options:

- Improvement of watershed conditions upstream with the long term aim of reducing flood peaks and sediment loads (see Impact O8).
- Development of flood management and mitigation plans for adoption by WUAs and kebeles.

Residual significance: low adverse, if mitigated; high adverse if not effectively mitigated.

5.4.4.2 Climate Change

Impact O10: climate change could affect project operation through, for example, higher temperatures and therefore higher water demands, or more intense rainfall and therefore more intense floods.

Analysis: a recent IWMI review of climate change predictions for the Upper Blue Nile River Basin (Kim *et al.* 2008) suggests a generally increasing trend in both precipitation and runoff in the Amhara region. This was determined by combining the results of various different models in a weighted scenario. In this analysis the standardised precipitation index, a commonly used measure of dryness/wetness over various time intervals, points to a reduction of severe drought events by the 2050s due to increased precipitation. Therefore, on balance it is not expected that there will be any water quantity problem related to future reduced rainfall. Nevertheless, it should be borne in mind that the IWMI analysis averages the outputs of a number of General Circulation Models (GCM), some of which *do* predict a reduction in annual runoff in the region. This less favourable prediction is also made in other reviews, such as Hassan (2006). In relation to floods, the IWMI weighted scenario predicts a slight increase in high flow levels in rivers (specifically, the flow which is exceeded 10% of the time will increase by 15 to 20%).

Since the water supply for the scheme is the lake, climate change is not foreseen to be a significant factor likely to affect its hydrological viability up to the middle of this century. The project itself will greatly increase the security of water supply to farmers and improve flood control, thereby mitigating against the potential impacts of climate change.

Mitigation options:

No specific mitigation measures are recommended for the MPIDP in relation to climate change and hydrology. However, the overall situation should be monitored so that appropriate measures can be taken to manage water resources at basin level (see Impact CE1 in Chapter 6).

Residual significance: not applicable.

5.4.4.3 Reduced Water Quality due to Pollution

Impact O11: during operation, the project is likely to have significant adverse effects on water quality unless mitigated. The principal areas of concern are (a) pesticides, (b) fertilisers, (c) salts, and (d) waste, both solid and liquid.

Analysis:

(a) Crop pests and diseases are serious problems in the PCA at present and will become worse with the intensification of agriculture (see Impact O12). Horticultural crops are at especial risk. In response, farmers will increase their use of pesticides for crop protection. Pesticide types, methods of application and associated practices such as cleaning equipment are such as to ensure multiple, frequent entry of pesticides and pesticide residues to water (see Impact O13). Once in the water, the active ingredients of the various products will either be adsorbed onto soil particles, or break down at various rates or, if stable, will maintain their toxicity and move into the food chain. The proximity of the command area to the lake and direct connections from the fields through the drainage system suggests that contaminants will find their way rapidly to the inshore waters of the lake. This is especially true of crops grown in water and with a high requirement for protection, such as rice. Contamination of surface water by pesticides will have direct negative effects on a variety of aquatic organisms, depending on the product in use and related factors, and indirect effects if the material enters the food chain and bio-magnifies. Of most concern are (i) fish, (ii) amphibians important as natural pest control agents (e.g. frogs), and (iii) birds. Some herbicides, such as atrazine, have a very high potential for contaminating groundwater and are highly persistent; atrazine is registered for use in Ethiopia in combination with other herbicides for control of weeds in sugarcane and maize (see Annex 8).

(b) Intensification of agriculture will result in a significant increase in the use of fertilisers due to (i) the use of improved seeds and crop varieties which require and respond to high nutrient levels, (ii) increased ability of farmers to purchase inputs, and (iii) a possible reduction in soil fertility if flooding and livestock are controlled (less silt, less scattered manure). Crops vary in their ability to take up nutrients from fertilisers according to growth stage, soil conditions, temperature etc., and is inevitable that a significant proportion of the nutrients in the fertilisers will be removed from fields in soluble form in drainage waters. The two elements of concern are P and N (as soluble nitrates NO_3), since these act as accelerants on aquatic weeds which will (i) choke drainage channels, causing very high maintenance requirements (Photo 5-3), (ii) possibly cause anoxic conditions during low-flow periods (due to use of all dissolved oxygen in the water by weeds and especially by algae), and (iii) bring these problems to the waters of the lake with potential cumulative effects.

(c) Development of the command area carries a high risk of secondary salinisation (MPIDP FS). The primary concerns are soil quality and the effects on crop growth. Impacts on drainage waters are a secondary concern. The water of Lake Tana is fresh and of good quality for irrigation, and so will not contribute to soil salinity. The risk is from a rise in groundwater due to excessive irrigation water applications and inadequate drainage, and then evaporation of the salty groundwater (see Impact O5). There no cumulative risk to surface water from salts in command area drainage under foreseeable conditions, and there is no risk to groundwater since this is already saline to some extent. The water in land drains from specific, high-risk soil areas within the command area may be slightly saline, e.g. at Weynit in Seraba Dabelo Kebele (Figure 4-9), but this will not present any significant hazard to aquatic wildlife downstream.

(d) Operation of the scheme will result in the generation of a variety of wastes, both solid and liquid. In settlements wastes will, initially, mostly be biodegradable since poverty results in low consumption of plastics, glass etc. As incomes increase there will be increased acquisition and disposal of plastic bags and other non-biodegradable debris. In the absence of any system for solid waste management, much of this will find its way into the nearest drainage channel, creating a health hazard and hydraulic blockage. In the absence of preferred sanitation facilities, drainage and possibly irrigation channels in and near settlements will be used for defecation, creating a health hazard. As the scheme develops, small-scale agricultural service industries will be established. Some will produce biodegradable wastes, e.g. husks and liquids from crop processing. If not useful locally, these waste materials may enter drains and affect water quality. Other small-scale facilities will produce potentially toxic liquid wastes with the potential to contaminate both surface and groundwater, e.g. used engine oils and solvents from workshops for maintaining pumps and tractors. At present the Woreda and Kebeles have essentially no resources or capacity to design and implement waste management programmes. Guidance on management of household wastes is given in EPA (2004)[85].

Mitigation options:

In all cases:

- Conserve existing riverine wetlands (see Impact O14) and restore the lakeshore wetland (see Impact O19) to act as buffers between the command area and Lake Tana.

(a) Pesticides

- Develop and promote Integrated Pest Management (IPM) (see Impact O13).
- Consider the strategic option of promoting organic agriculture (see Impact O13).

(b) Fertilisers

- Carry out crop-specific research to refine fertiliser recommendations (see Impact O38).
- Raise capacity of extension service to deliver recommendations to farmers (see Impact O38).
- Consider the strategic option of promoting organic agriculture (see Impact O13).

(c) Salts

- No action recommended with respect to drainage water salinity, except monitoring (see Chapter 8).

85 EPA. 2004. Technical Guidelines on Household Waste Management.

(d) Solid and liquid wastes

- Identify and promote appropriate latrine technologies (see Impact O32).
- Support kebeles to establish and operate basic solid waste management systems (see Impact O39).
- Enforce drainage channel maintenance duties of WUA members (see Impact O4).

Residual significance: moderate, unlikely to be fully mitigable by foreseeable measures.

5.4.5 Pests & Diseases

5.4.5.1 Changes in Pests and Diseases

Impact O12: intensification of agriculture is highly likely to result in the intensification of problems from pests and diseases.

Analysis: at present crop pests and diseases cause major economic losses in the PCA. Most damage is caused by insects, followed by weeds, storage pests, and plant diseases (see Table 4-17). The proposed crop baskets include wet season rice, teff, niger seed (*noug*) and finger millet, with dry season (irrigated) cash crops including vegetables, spices, oil seeds, pulses and some cereals (Table 2-3). Irrigation and drainage will remove primary constraints to crop productivity; after plant nutrition is dealt with (by fertilisers), biotic constraints (weeds, insects and diseases) are likely to prove the most significant limiting factors, especially for horticultural crops.

(a) Cutworm and red tefworm are especially serious for crops grown in residual moisture near the lake (Akalu Teshome *et al.* 2009). Improved wet season drainage is likely to create more favourable conditions for cutworm larval survival (reductions in extent and duration of soil flooding, which can drive cutworms to the surface where they may be killed by exposure or predated). In addition, moist conditions created by dry-season irrigation will also favour these pests. The development scheme will involve near-continuous growth of cutworm host plants.

(b) At present the landscape is relatively diverse and provides habitat for a variety of birds (see Section 4.3.3), some of which are insectivorous and therefore provide a form of natural pest control (although some birds are now regarded as occasional pests on cereal crops due to changing agricultural practices (see Section 4.3.3.6)). After development, the landscape may become less diverse, especially if wetlands are drained, with potential loss of these natural predators.

(c) More importantly, the intensified cropping systems will rely on improved crop varieties which tend to require agrochemical inputs to reach their yield potentials. Sime will be disease and pest-resistant, but their widespread use is likely to contribute to a reduction in overall crop varietal diversity, therefore increasing the risk of pest and disease outbreaks.

Mitigation options: mitigation options are identified in the project's Phase 1 Pest Management Plan (PMP) attached at Annex 8. Key measures in the Plan include:

- Targetted research on prevention and control techniques for the major insect, weed and disease problems in the area (for example, water management and field sanitation techniques to control cutworm larvae, cultivations after harvest to control red tefworm, any technique that might control head blast in finger millet and rice, any techniques that might control root rot in hot pepper).
- Development and delivery of appropriate preventive extension packages (farmer training in problem avoidance and management techniques).

Note: a substantive review of crop protection and pest management issues in the Dembia, Fogera and Libo Kemkem project areas is given in a recent ARARI report (Akalu Teshome *et al.* 2009), together with detailed proposals for management measures including the use of pesticides.

Residual significance: high: there is no foreseeable scenario in which crop (and livestock) pests and diseases will cease to be a significant problem in the project area; they are and will continue to be a major factor in limiting productivity and affecting product quality.

5.4.5.2 Inadequate Pest Management & Improper Use of Pesticides

Impact O13: the scheme will intensify problems from crop pests and diseases; pesticides are poorly regulated in Ethiopia; in the absence of alternatives, uncontrolled and inappropriate use of pesticides is likely to increase considerably, with significant adverse impacts on exposed workers, residents, wildlife and ecosystems.

Analysis: to date the use of pesticides in the PCA has been limited by cost and availability. Agricultural intensification will alter this picture, creating both a demand for better pest and disease control and the funds to purchase pesticides. If unmanaged, this process is highly likely to result in the same adverse impacts on human and environmental health experienced in many other locations worldwide under similar circumstances. Specific issues (obtained from the literature and from direct observation) include: use of unregistered pesticides; unapproved uses; incorrect application rates, methods and timing; occupational exposure through many pathways including handling and early re-entry of workers to fields; lack of personal protective equipment or devices (PPE, PPD: Photo 5-4); unsafe storage; unsafe packaging; onward sale of re-packaged or out of date pesticides; mixing chemicals near water; pesticides in runoff from fields and from cleaning equipment near or in water (see Impacts O22); re-use of containers for food and water storage (see, e.g. Arne 2004, Esheteu Bekele *et al.* 2006, PAN 2006).

Photo 5-4: Aphid treatment, Grass peas (Guaya), Lake Tana, Jan. 2009

As stated in Nyambo & Youdowei (2007), pesticides/active ingredients causing most concern in Ethiopia are organochlorines and pyrethroids (deltamethrin, cypermethrin, etc.). Persistent pesticides, such as endosulfan, are chlorinated hydrocarbons with potential significance for the environment and possibly as residues on crops. Many of the organophosphates and pyrethroids have high levels of toxicity (they are mostly in WHO Class II, "moderately hazardous"). In addition, pyrethroids are broad spectrum pesticides and as such kill all organisms including natural enemies; therefore they can cause secondary outbreaks of pest organisms, as has been noticed in the outbreak of red spider mites in onions in the Awash valley (Abate & Ayalew, 1994) and woolly whitefly in citrus in the central Rift Valley of Ethiopia (Getu *et al.* 2001).

A particular concern is the widespread use of malathion, a broad-spectrum insecticide, against aphids on grass pea and against African bollworm on chickpea, despite the availability of specific insecticides such as dimethoate and primicarb (Akalu Teshome *et al.* 2009). Malathion kills honeybees, which are of major importance for both pollination services and honey production in the project area (see Kerealem Ejigu *et al.* 2009), as well as (presumably) having wider adverse effects on the ecosystem. Sevin (carbaryl), DDT and 2-4 D are also reported to have adverse direct or indirect effects on bee populations in Amhara (Kerealem Ejigu *et al.* 2009).

At present Ethiopia has a relatively weak regulatory and training infrastructure with respect to pesticides. Even the internationally-assisted high priority programme for disposal of obsolete pesticide stocks has been at risk of closure due to lack of demonstrated government commitment and progress[86]. Ethiopia has some experience with IPM, including the use of Farmer Field Schools, but as yet there is no

[86] ASP. 2009. Africa Stockpiles Programme Annual Report July 2008-June 2009. www.africastockpiles.net

mainstream commitment to IPM as the way forward in agriculture. A useful review is provided in Esheteu Bekele *et al.* (2006)[87].

On a global level, the World Bank's response to the negative effects of inappropriate use of pesticides has been (i) to develop a formal pest management safeguard policy (OP 4.09 Pest Management), and (ii) to promote the use of integrated pest management (IPM) in its projects. For this purpose the Bank has formed an alliance with the CGIAR Systemwide Programme on Integrated Pest Management (SP-IPM), which is also sponsored by UNEP and FAO.

In relation to the Bank's policies, it is clear that the MPIDP will involve use of pest control products that are significant from both an environmental and health perspective. Accordingly, a Phase 1 Pest Management Plan has been developed and is attached at Annex 8.

Note: the PMP does not include a screening of individual pest control products since at present the ESIA study team has no information that pesticides will be financed by the Bank. This issue can be dealt with during preparation of the Phase 2 PMP (see Annex 12.3).

Use of inorganic pesticides (and fertilisers) would be avoided if the scheme was run as a certified organic enterprise. The feasibility of organic smallholder commercial agriculture in the Lake Tana floodplains is unknown, but if it proved to be viable it would greatly reduce or avoid negative impacts on Lake Tana water quality caused by agrochemicals.

Mitigation options: a strategy and measures for mitigating the impact of increased, unsafe use of hazardous pesticides is presented in the attached PMP. The measures relate to (i) regulation, which has to be dealt with at federal level, (ii) research, and (iii) extension. Key measures are:

- Establish IPM as a formal federal policy and provide resources and powers to MoARD to implement the policy.
- Strengthen agricultural research capacity at national and regional levels and re-orient it towards IPM.
- Build on this study's Phase 1 PMP (see Annex 8) to develop a Phase 2 PMP, and then use this to build IPM into the project concept for MPIDP (and also the Ribb project), including a coordination mechanism for all aspects of crop protection extension.
- Develop specific IPM measures for the individual crops and crop sequences and combinations for MPIDP.
- In combination with the above, screen individual registered crop protection products and develop a list of approved products for last-resort use in the irrigation scheme.
- Establish and implement a similar system of integrated vector management (IVM) for livestock husbandry.
- Development and implement a strategy for the protection and development of beekeeping, including close coordination with ARARI crop protection researchers developing crop production and protection strategies, and involving the Ethiopian Beekeepers' Association.
- Establish an enforcement capability to prevent the sale or improper use of pest and disease control products not approved for use in the scheme.

In addition, as a strategic option:

- Consider trials to determine the feasibility of organic agriculture in the floodplains, with associated niche marketing (possibly a green label and market identity for produce from Lake Tana).

Residual significance: if all these measures can be implemented, the risks to human health and lake ecosystem will be greatly reduced but not avoided. A major effort will have to be made to make these measures work - and they will not be effective in preventing cumulative damage to Lake Tana unless also applied everywhere else in the Basin.

87 E. Bekele, F. Azerefegne & T. Abate. 2006. Facilitating the Implementation and Adoption of IPM in Ethiopia. Planning workshop, Oct. 13-15, 2003 at EARO.

5.4.6 Ecology

5.4.6.1 Habitat Degradation

Impact O14: the project will alter vegetation communities in the command area and its vicinity due to changes in hydrological conditions. It will also result in a change in the pattern of habitats (habitat diversity) and in the balance between wetlands and farmland (crops). Overall both habitat diversity and the area of wetlands are likely to continue to decrease, especially extent and quality of the riverine wetlands.

Analysis: channelisation of the Dirma River and other natural drainage channels is likely to have significant adverse impacts on the hydrology of the riverine wetlands. Hydrological connections between river channels and wetlands will be reduced or cut by dykes during the rainy season, reducing the extent of and depth of floods in typical years. The existing high human and livestock pressure on all natural resources including wetlands is expected to continue, and may increase if common property grazing resources are reduced in favour of irrigated cropping. Wetland drainage is likely, to create additional land for cultivation.

Degraded and reduced habitat will in turn result in reduction of feeding and breeding grounds of fish (and hence affect the fish stock in the northern part of the lake), as well as of aquatic birds and other groups of animals (mammals, reptiles and amphibians).

Note that (i) the Ethiopian Science and Technology Commission is sponsoring an initiative to declare Lake Tana a Biosphere Reserve and possibly ad World Heritage site; (ii) the ANRS BoCTPD and Bureau of Industry and Investment are preparing for a study to promote the sustainable use of the land-water interface around the lake, involving both cadastral survey work and land-use planning[88].

Mitigation options:

- Manage the project to ensure that habitat diversity is retained, specifically by (i) maintaining hydraulic and ecological connections between the Dirma River and other drainage channels and their associated riverine wetlands, and (ii) developing and implementing a wetland management plan for the riparian wetlands.
- Investigate the feasibility of profiling riverbanks with a specific design favourable for Catfish and Tilapia spawning, and if successful, upscale and implement.
- Manage the lakeshore wetlands as a buffer zone between the lake and the command area, with restricted access and controlled utilisation (see Impact O19).

Residual significance: initially high adverse, medium adverse if adequately mitigated.

5.4.6.2 Continuing Impacts on Birds

Impact O15: the project area is important for international migratory birds. The project will increase pressure on the natural environment resulting in degradation and loss of bird habitats (rest areas for migratory birds, roosting areas, breeding sites and feeding resources) and increased disturbance of birds.

Analysis: the importance of the core study area and the Dembia plain as a whole for international migratory birds is supported by several quantitative studies undertaken since 2006. The wetlands along the Dirma River are now recognised as particularly valuable habitats for birds.

Although some of the main wetlands in the area have been excluded from the command area, impacts on bird habitat will occur due to altered water regimes, ongoing impacts of channelisation, further increases in grazing pressure, conversion of communal pasture to farmland, and the use of pesticides with many potential pathways to affect birds.

Food resources may be affected due to changed hydrological conditions with consequent impacts on fish and other wetland bird food sources (e.g. frogs).

Better access and intensification of human activity around and in wetlands will increase levels of disturbance with potentially significant harm during the breeding season. Reduced habitat and food resources may force birds to increase their predation on crops, setting up possible scenarios of pest and pest control by farmers.

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88 Information from ENIDP RPCO, 01 Dec. 2010.

Mitigation options:

- Information, education and awareness (IEC) programmes for local residents, especially children, with respect to birds and their protection, and specifically migratory birds.
- Manage the project to maintain the integrity of the riverine wetlands (see Impact O14).
- Restore the lakeshore wetlands (see Impact O19).

In addition, a policy-level option applicable to both this project and all other wetlands, and one recommended many times by concerned national specialists, is:

- Become a party to the Ramsar Convention; this would give Ethiopia access to additional tools and resources for wetland conservation and management.

Residual significance: initially high adverse, medium adverse if adequately mitigated.

5.4.6.3 Continuing Impacts on other Wildlife

Impact O16: wetland degradation and loss and an intensification of human activity in wetlands and along the lakeshore could affect habitat necessary for hippopotamuses and large reptiles (monitor lizards, python).

Analysis: the wetlands and lakeshore in the project area are important for hippopotamus and for large reptiles. At present these habitats are being degraded and lost, a process that will continue both with and without the project, unless mitigated. Reduced hippo habitat, especially for grazing, and the presence of irrigated crops near the lakeshore in the dry season is a combination highly likely to result in adverse wildlife-farmer interactions. The hippos would be a significant component of any future tourism package based on short trips to Gorgora from Gonder as part of the Northern Circuit. Other mammalian wildlife in the area (hyaena, monkeys, etc.) are not considered rare, endangered or charismatic. Python, like other snakes, tend to be killed on sight, so that any reduction in habitat and increased in human activity is likely to have negative effects on remaining python populations.

Mitigation options:

- Retain habitat diversity and quality by protecting existing wetlands (see Impact O14).
- Restore the lakeshore zone (see Impact O19).

Residual significance: low adverse if habitats are adequately conserved and restored.

5.4.6.4 Introduction of Invasive Species

Impact O17: operation of the project will create an ongoing risk of the introduction and spread of invasive species of plants and animals.

Analysis: as described for Impact C11, the Lake Tana Basin is at risk from invasive species, specifically (i) alien fish, and (ii) water hyacinth. Other risks may exist but have not been positively identified (*Azolla* could be introduced in association with the rice cultivation likely to be a major crop when the project is operational, but its potential to threaten the lake's aquatic ecology is not known). If the project involves an aquaculture component (see recommendation under Impact O20) there is the possibility of misguided introduction of fish not native to the lake. Water hyacinth could be introduced at any moment if, for example, channel maintenance equipment is brought from an infected area and not cleaned prior to being used on the project. Once invasive species arrive in a new area control becomes very difficult or impossible, so prevention is the preferred choice of counter-measure.

Mitigation options:

- Ensure that fisheries managers are aware of the absolute requirement to avoid importation of non-native fish.
- Ensure that all equipment required for scheme O&M is clean and completely free of plant parts and mud, before entering the Basin (if feasible), or at least by inspection before use in local waterways.

Residual significance: nil adverse if control measures are implemented effectively and in perpetuity.

5.4.6.5 Loss of Agrobiodiversity

Impact O18: (a) traditional land races of crops could be displaced by modern varieties, causing a loss of crop genetic variety; (b) traditional breeds of livestock could be displaced by new breeds, resulting in a loss of animal genetic diversity.

Analysis:

(a) Highland Ethiopia is the centre of genetic diversity for a number of important crop species, among them: barley, durum wheat, sorghum, linseed, finger millet, chick pea, cow pea, niger seed, Arabica coffee, teff, ensete and oats.[89] Constraints such as low soil fertility, lack of improved varieties (for most crops), inappropriate time of seed supply, insect pests, weeds, diseases, lack of improved agronomic practices such as appropriate seed rate and planting method, cropping system, frequency and time of irrigation affect yields in the project area.[90] Farmers in the PCA mostly use traditional varieties with well known characteristics. For example, the local sorghum variety (*zengada*, also called *abro adek*) tolerates waterlogging, produces crop residues for feeding to livestock, and can be used to make the local beer (*tala*), thereby outweighing its disadvantages which include low yields and late maturity - it may occupy land for 9 months in any one year and is therefore a constraint to multiple cropping. Although yields may be low, they are consistent under the low-input low-output system and are therefore a low-risk option for local residents. These varieties respond to better husbandry (seedbed, time of sowing, fertilisation, weed control, etc.) but not nearly as much as improved varieties. The project concept is to move from low-inputs low-outputs to an intensive system with much higher outputs, which will require the use of new crop varieties, higher inputs and higher standards of husbandry. The primary concern is that over time existing crop varieties will be displaced and, unless preserved *ex situ*, their genetic characteristics will be lost for future crop breeding. A secondary concern is that the promotion of new varieties without sufficient local knowledge or extension back-up may expose farmers to unnecessary crop risks of crop failure.

Although the process of agrobiodiversity loss is well known, its potential importance in the PCA is not: the genetic value of the existing crop varieties in the project area is not known, nor whether these varieties are specific to the command area and/or Dembia Plain or are in common use around the lake. This is a very specialised field of study.

Note: within Ethiopia the Institute of Biodiversity Conservation (IBC) is the national focal point for plant genetic resources conservation for food and agriculture. Ethiopia is a party to the Convention on Biological Diversity and the International Treaty on Plant Genetic Resources for Food and Agriculture, and has developed a National Policy for the Conservation and Development of Plant Genetic Resources. Since the key to protecting the biological heritage of Ethiopia lies in the involvement of local people, a proclamation was approved in 2006 to regulate access to genetic resources and associated community knowledge, innovations, practices and technologies, and to protect the rights of local communities. The IBC has developed *in situ* landrace conservation and enhancement programmes that involve breeders, farmers and others, in several stages of maintenance, restoration and improvement processes of traditional crop varieties and established Community Genebanks (CGB). The CGBs cover 22 crop species consisting of 400 farmer varieties in six agroecological zones of the country. A similar initiative has been proposed by IBC for conservation of crop wild relatives and wild plants relevant to food production, but these efforts are constrained by lack of resources.[91]

(b) Livestock in the PCA includes cattle, sheep, goats, donkeys, mules and poultry, as well as several varieties of honeybee. Diversity in the farming enterprise reduces risk. The local breeds can be assumed to have characteristics adapted to the stress of the local environment, such as feed scarcity, high disease burdens and waterlogging. One example is Fogera cattle, a local breed developed in the last century (Photo 5-5). However, the adaptation is at the cost of generally low yields and productivity. Mating is uncontrolled and there is little evidence of improved breeds. When these are introduced they may not be able to thrive under local conditions - for example, the introduction of Rhode Island Red and Lohman White chickens has not been a success due to their susceptibility to the diseases common in the area.

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89 See Unruth, J.D. No date. The dilemma of African agrobiodiversity: Ethiopia and the role of food insecurity in conservation.

90 See Akalu Teshome *et al.* 2009. Agricultural potentials, constraints and opportunities in the Megech and Ribb rivers irrigation project areas in the Lake Tana Basin of Ethiopia.

91 See "Institute of Biodiversity, January 2008. Ethiopia: Second Country Report on the State of PGRFA to FAO".

Photo 5-5: Local cattle by Lakeshore, Megech PCA

The FS proposed to improve livestock by (i) breed improvement by artificial insemination, (ii) cattle and small-ruminant fattening, including use of the indigenous dual-purpose Fogera cattle for this purpose, (iii) improvement of poultry breeds, (iv) promoting beekeeping and hive yields by better training, technologies and equipment, and (v) improving veterinary services. This will, inevitably, displace local breeds with the associated loss of genetic potential. The significance of any such loss cannot be judged at present, but is likely to be low due to the widespread presence of similar genes in the very large Ethiopian livestock population.

Mitigation options:

- As part of a regional initiative to respond to rapid change, establish a programme to survey crop and livestock diversity in the Lake Tana floodplains and determine what further conservation steps should be taken; involve the IBC in this programme, in cooperation with local agricultural research organisations such as ARARI.
- Use improved varieties which are already grown in the region and have proved to be well adapted (such as Pioneer, BH 540, BH 660, BH 542 for maize, HAR 1685, HAR 604 for wheat, and x-jigna for rice; for cattle, focus on the Fogera breed).

Residual significance: if diversity is conserved, residual impacts will be positive.

5.4.6.6 Increased Stress on Lakeshore

Impact O19: operation of the project may intensify pressure on the lakeshore zone, especially from young people who do not have access to land within the command area, resulting in further loss of its economic value and ecosystem functions.

Analysis: for centuries the lakeshore zone has been a critical wetland habitat with major economic value, particularly for fish, for papyrus (for *tankwas*), for reeds and grass (for thatch), and as dry-season emergency grazing. It is now under extreme pressure, primarily from the expansion of agriculture, and especially as a source of farmland for young farmers for whom there is no land elsewhere. For the most isolated people households in Achera Mariam and Seraba Dabelo Kebeles, the lakeshore is a "*gift given by God*" to ensure their survival. The zone has also been affected by changing hydrological conditions associated with hydropower generation, specifically the major, temporary drop in water levels in 2003 which resulted in widespread loss of papyrus beds around the lake. Aware of the importance of the lakeshore and in line with a recent directive from the ANRS BoEPLAU, the Dembia Woreda environmental protection office has attempted to control land use by the lake, with actions including the imprisonment of local residents. Relations between the administration and farmers concerning this area are now tense.

These circumstances suggest the need for a different approach. It is possible that by implementing a lakeshore restoration project with the active participation of local land users, a win-win situation could be produced: protection and conservation of the lakeshore could re-establish the papyrus beds and their ecological functions, whilst the land users would benefit from the increased productivity of the zone (except for crops) and could find economic opportunities as managers and/or guides - especially if the scheme is linked to tourism development at Gorgora. As a minor benefit, the zone would also be able to act as a buffer between the command area and the waters of the lake, with respect to protection of water quality.

If successful, this co-managed restoration project could be rolled out around the lake, which would be a major achievement initiated in the current UN International Year of Biodiversity. To some extent, it could also act as a biodiversity offset[92] to compensate for the inevitable impacts on fisheries resulting from the project's manipulation of the Dirma and other rivers. It is also consistent with the Bank's policy under OP 4.04 to promote the restoration of degraded habitats.

Mitigation options:

- Develop and implement a lakeshore restoration programme in Seraba Dabelo and Achera Mariam Kebeles using co-management principles as a **biodiversity offset**.

Residual significance: if successful, highly positive.

5.4.7 Fish and the Fishery

5.4.7.1 Changes in River Flows, Morphology and Hydrology

Impact O20: the loss of habitat caused by channelisation of the main rivers will continue to affect the lake fishery, specifically by reduced recruitment of *Clarias* and Tilapia. Additional negative impacts on fish could occur as a result of (i) changed hydrology of wetlands, (ii) reduced flooded area, and (iii) pesticide runoff in drainage waters. The *Labeobarbus* species might benefit from increased water in the Dirma due to reduced abstraction for local small-scale irrigation.

Analysis:

(a) The loss of habitat likely to be caused by channelisation of the main rivers, changed wetland hydrology and reduced flooded areas is likely to have an ongoing effect on the breeding and nursery habitats of the fishes (especially for the cichlids, catfishes and *Labeobarbus* spp. - juvenile *Labeobarbus* may use riverine wetlands before returning to the lake). Fish recruitment will be reduced in proportion to the loss of breeding sites or access to breeding sites, with consequent impacts on fish stocks in the lake, especially in the north.

(b) *Labeobarbus* migration upstream along the Dirma River could be affected by the Irish crossing (ventilated ford) to be built to carry the main canal service road across the river. This will depend on the exact details of the design, especially the diameter and length of the pipes, their invert levels compared to the natural bed of the river at the downstream end, and flow velocities.

(c) *Labeobarbus* migration upstream on the main Dirma tributaries could be affected by crossings under the main canal (siphons). The behaviour of Lake Tana *Labeobarbus* species in relation to siphons is unknown; high velocities in enclosed pipes can be expected to act as a deterrent to upstream movement.

(d) Adult *Labeobarbus* require a certain minimum depth of water for migration, thought to be around 20 cm (Abebe Getahun, pers. comm.). Any reduction in flows due to channelisation or diversions in tributaries or the main river is likely to have significant adverse effects on adults migrating and juvenile fishes returning to the lake. It is likely that the supply of irrigation water from the lake will reduce localised diversions in the command area, but will not affect the diversion from smaller watercourses upstream.

(e) Increased access to markets due to better roads could result in an increase in fishing pressure, with intensification of extremely unsustainable practices such as 100% netting of rivers.

(f) Reductions in water quality caused by use of fertilisers could affect macrophyte cover, zooplankton and fishes, especially juveniles. A particular hazard will be pesticide runoff (see Impact O22).

Any reduction of fish stocks in the lake resulting from this combination of factors will directly affect fishers and their families. An estimated 3,000 people are directly dependent on the major activities of fishing, marketing, and processing for their livelihood.

92 Biodiversity offset: a measurable conservation outcome resulting from actions designed to compensate for significant residual adverse biodiversity impacts arising from project development after appropriate prevention and mitigation measures have been taken. The goal of biodiversity offsets is to achieve no net loss and preferably a net gain of biodiversity on the ground with respect to species composition, habitat structure, ecosystem function and people’s use and cultural values associated with biodiversity (BBOP 2009).

Mitigation options:

- Review the detailed designs of the major main canal service road and drainage crossings prior to construction to ensure they comply with best practice guidelines for fish passage at structures and with what is known about *Labeobarbus* swimming behaviours (note: this is a highly specialised subject; outline ToR are provided in Annex 12.1; this task could be carried out as a sub-contract under the Management Services Contract in connection with the design review and endorsement activity).
- Carry out a comprehensive study of the fish fauna of the major Dembia plain rivers (Dirma, Nededit, Megech) and the associated wetlands focusing on wet season fish behaviour and habitat requirements, especially for migration of the *Labeobarbus* spp. (this recommendation is understood to have been incorporated in the "ToR on Preparation of Detailed Implementation Manual for Environmental and Social Management Plan of Ribb River on Fish Resources", a study now under implementation[93]).
- Improve the regulation and control of fishing activities in and near the command area. It is important (i) to organize and strengthen the fishers' cooperatives, and (ii) to try to protect the lake and the rivers from illegal fishing. This would involve major fisheries management measures such as control of net mesh sizes, banning cross-river netting, and fisheries closure during key times such as spawning runs. A high degree of participatory management will be required to ensure effective implementation of these measures in such very poor communities. Note: it is understood that a new BoARD - FAO project on Lake Tana Fisheries Management through Community Participation was approved in early Dec. 2010 to address these issues.
- Establish within ANRS BoARD and Dembia WoARD the capacity to develop and maintain a register of fishery data, to conduct awareness workshops, and to manage and monitor fishing activity (licensing, closing areas for a season, monitoring types of fishing gear, etc.). Note: it is understood that the new fisheries management project (see above) will include training of fisheries officers at zonal, woreda and kebele levels and the establishment of Kebele Fish Management Units in all the kebeles bordering the lake.
- An important aspect of any lake fisheries management programme would be a loan facility to enable legal lake fishers to upgrade their equipment and boat-to-market quality (purchase of fishing gear, boats, engines, cold stores).
- For fisheries management, establish a strong hydrological monitoring activity to measure the flows in the tributaries: these are critical to the sustainability of the *Labeobarbus* spp. in Lake Tana. Sufficient flow is required in the feeder rivers for a large part of the year (i) to allow the movement of the adult fishes in their spawning migrations, and (ii) to permit the juveniles to return to the lake after hatching. About 20 cm depth of water is the minimum required to allow the larger species to migrate to and from the Dirma and Nededit Rivers.
- Consider contributing to establishment and/or operation of a regional or zonal fish hatchery.
- Consider, as an **enhancement measure**, the development of extensive or semi-intensive aquaculture in the project area for Catfish and Tilapia. Despite the low habitat diversity in irrigation canals and night reservoirs, they will be able to support a certain level of fish production. The presence of fish in the canals would assist in controlling some disease vectors by preying on insects and their larvae. Successful aquaculture might (i) reduce the pressure that otherwise would have been exerted on the natural fish stocks of Lake Tana, contributing to its conservation, and (ii) increase the pressure to avoid contamination of all water by agrochemicals and wastes. A note on potential production levels is included at Annex 6.5, and indicates a potential harvest of some 9.5 t/yr, worth approx. ETB 105,000 before costs. (Note: this should be compared with the estimated free fish production from existing wetland habitats and rivers which will be affected to some degree by the project: 300 t/yr; see 4.3.4.5).

Residual significance: if all these measures are implemented effectively and are successful, the residual impacts on the fish fauna and fishery could be neutral or positive. However, protection of fish stocks and successful fisheries management in poor communities with high population pressure is extremely difficult, with few examples of success elsewhere in Ethiopia. Basin-wide measures are required to ensure conservation of the fish stocks in Lake Tana.

93 A draft interim report on this study became available in Sep. 2010 (Eshete Dejen 2010), but this does not include any consideration of the fish of the Dembia Plain or Megech or Dirma Rivers. Consequently this wet season survey remains to be done.

5.4.7.2 Fish Entrainment at Pumping Station

Impact O21: fish may be entrained in (sucked into) the pumps at the pumping station.

Analysis: the scheme requires some 30.5 million m^3 of water per year; this will be drawn directly from the lake during the dry season by 5 pumps, each rated at 4,550 m^3/hr. Water will flow to the pumps along an intake channel extending some 300 m into the lake. The shallow inshore waters of the lake are important for fish. To be entrained, fish would have to enter the channel and pass through the trash rack. The trash rack will automatically prevent entrainment of large fish, but smaller fish, fish fry and fish larvae will be able to pass through. In this location water velocities will be accelerating as they approach the pump intake wells, eventually exceeding the swimming ability of the smaller fish. Fish or fish fry which become entrained in the pumps will probably be destroyed, either directly or through pressure changes (although there is some evidence that mortality is size and species-specific, as well as depending on pump design: see Baumgartner *et al.* 2009). Fish larvae may survive, but then would be in the canal system with no opportunity to return to the main river system.

With existing information it is impossible to predict either the numbers and types of fish that will be entrained, or the effects on specific fish populations of such entrainment. The impacts can only be determined by direct measurement during project operation, a process requiring significant specialist resources and time. It is unlikely that damage to fish populations due to entrainment will be significant when compared with degradation and loss of key habitats in the rivers and wetlands.

Various techniques are available to reduce fish entrainment at pumps, ranging from physical (screens) through behavioural (design of intakes so that flows are of limited attractiveness to fish) to deterrence (electrical, acoustic and bubble barriers). Screens are usually highly impractical since, if sufficiently fine-meshed to exclude fish fry, they block with weeds and algae very quickly. However new designs are becoming available (such as self-cleaning brushed-cone screens). The other techniques require detailed knowledge of specific fish behaviours, not available at present for Lake Tana Labeobarbs (the group of most concern).

Mitigation options:

- Offset possible impacts on fish due to entrainment by improving fish conservation and management elsewhere (see Impact O20).
- Subject to resources: during project operation, design and implement a survey to detect and count fish entrained in the pumps (this would be an ideal subject for a research student). Take action based on the significance of the findings (for example, retrofit a deterrence system or self-cleaning screen to the intakes).

Residual significance: no conclusion possible at present time.

5.4.7.3 Impact of Reduced Water Quality

Impact O22: water quality for fish may be lowered due to increased salinity and the use of agrochemicals.

Analysis: the rivers, streams and wetlands in and flowing through the PCA are habitat for various types of fish and other aquatic organisms, which are important scientifically, ecologically and economically. These organisms also provide food for higher level of the food chain, especially birds. The project will affect water quality by augmenting normal dry season and wet season flows with drainage (return) flows from fields. These return flows will carry any chemicals added to the fields and not immobilised, bio-degraded or taken up by plants, including pesticides, fertilisers and salts (see Impacts O11 and O13).

(a) Slightly increased salinity is not considered a serious threat to water quality for fish: catfish and tilapia are relatively less sensitive and can take avoidance action if necessary; the (probably) more sensitive migratory Labeobarbs move upstream and downstream during higher flows which will not be affected by slightly saline runoff, although the behaviour and salinity tolerance of the juveniles is not known.

(b) The nitrogen and phosphorus in fertilisers will act as an accelerant to the already high growth potential of weeds and other aquatic organisms, risking algal blooms and subsequent de-oxygenation in stagnant or shallow waters.

At the present time it is not possible to quantify these potential impacts but, by analogy with other areas, the risk is high. Potentially equally or more damaging will be the predicted increase in use of pesticides, especially those which are broad-spectrum and/or have high toxicity to aquatic organisms, such as endosulfan (a chlorinated hydrocarbon) and the various pyrethroids. Even when applied correctly, these chemicals tend to end up in drainage waters especially from crops such as rice; when handled and applied as widely observed in Ethiopia, addition of these chemicals to waters draining directly to Lake Tana is a certainty, with potentially highly significant direct and indirect local and possibly (eventually) lake-wide consequences.

Mitigation:

- Develop and implement an intensive, coordinated and thorough IPM approach to all agricultural activities in the project area, combined with strict enforcement of pesticide controls and major awareness and extension programmes (see Impact O13).
- Maintain all existing wetlands and restore those that have been degraded, to act as buffers between the PCA and the waters of Lake Tana (see Impact O19).

Residual significance: it is inevitable that water quality will be degraded locally as a result of agricultural intensification in Lake Tana's floodplains. The severity of the degradation will depend on the effectiveness of the measures implemented. The major risks are to the lake are eutrophication (caused by excess nutrients) and pesticide bio-magnification up the food chain.

5.4.8 Social

5.4.8.1 Cultural Constraints on Rapid Social and Economic Change

Impact O23: the very strong cultural traditions in the area may prevent or slow down the uptake of new attitudes and behaviours necessary for successful uptake and operation of the scheme. There will also be the opposite effect: the project will bring radical change to local lifestyles by opening the area up to outside influences and creating opportunities to develop skills and to change attitudes and behaviour.

Analysis: this analysis focuses on the impact which cultural resistance to change might have on the project, rather than the project's impact on local culture. The PCA lies within and forms a part of the heartland of Amharic culture, characterised by strong cultural traditions affecting all aspects of life including *inter alia* dietary preferences, and dominated by the Church and its strict religious observances. The religious calendar includes a very large number of holy days on which working the land (cultivation, sowing, weeding, harvesting) is not normally permitted, although watering, threshing and transporting goods are (Table 4-21): 19 days per month gives a total of some 228 days per year with some religious restrictions on agricultural work, excluding Sundays. There are also extensive strict periods of fasting. Rigid observance of these restrictions during project operation will affect farmers' ability to undertake time-critical agricultural operations such as water management on an 8-day cycle (if this involves adjustment of intakes etc.), or cultivation of the difficult vertisols on the few days when moisture conditions are suitable. The periods of fasting will restrict the local market for many perishable livestock products, and the dietary necessity of *injera* will require families to continue planting teff and sorghum to ensure household supplies. These factors, together with (i) related cultural practices such as the many constraints on the freedom of women to make their own choices with respect to marriage, child-bearing, education and investment, and (ii) the overbearing need for households to practice risk-avoidance in economic decision making, are likely to be very important in the early years of project operation. **Cultural change on the scale required for all households to maximise their benefits from the project investment is likely to take at least a generation** and may be resisted by some members of the Church.

Mitigation options:

Assuming that cultural change is necessary to climb out of poverty, a number of measures can be taken to accelerate change:

- Adult literacy classes (required in any case for understanding agricultural extension advice, input labels, contracts, and market conditions).
- Electrification (required in any case for many aspects of economic and social betterment).
- Education to higher grades (necessary to provide the skills needed by the next generation).
- All-weather road access (a major determinant of change, and essential in any case for providing inputs and services and for taking products to market).

Until such time as no longer needed, it will also be necessary to:

- Establish and maintain a dialogue with the Church so that church elders understand the technical requirements of the project, and therefore will give their congregations the religious dispensations necessary to work on religious holidays.
- Support the formation and operation of local groups and associations to offset the disruption of social networks caused by land reallocation and initial operation of the project.

Residual significance: the likely residual significance of unchanged cultural traditions for the uptake of the project's benefits is extremely difficult to evaluate: it is not possible to predict the speed or nature of all social changes under the complex conditions of project implementation.

5.4.8.2 Impacts on Women

Impact O24: the project may add to the already extreme workloads of women, preventing women and their dependent households from benefitting from the project and, on a larger scale, preventing full uptake of the project's agricultural opportunities. Impacts on landless women may be positive or negative (or both).

Analysis: in the command area women work harder and die earlier than men. Although almost all the command area population are poor and vulnerable, women are likely to be the group most severely affected by the project in terms of increased work loads. Specific demands will include (i) the requirement for additional field operations due to the demand of the new, higher yielding crops for more care such as weeding, (ii) additional demands for work related to livestock, due to the reduced availability of communal grazing land and the need for possible cut and carry activities for stall-feeding, and (iii) the need for additional child care vigilance if water-filled channels are constructed close to houses.

A further issue is the possible exclusion of women from participation in new management structures (WUAs, cooperatives) due to patriarchal cultural norms.

On the other hand, if the project incorporates effective gender-related components it could provide major benefits to women and hence to PCA families. Any such initiatives must be accessible to landless women as well as families with irrigated land, since most employment opportunities are likely to be taken up by men.

Mitigation options:

Mitigation options for probable negative impacts on women and measures to enhance benefits focus on (a) reducing domestic work loads by various measures, (b) increasing representation in decision-making, (c) providing specific economic opportunities, and (d) empowerment through education.

- Provide safe domestic water supplies near housing (see Impact O34).
- Provide easier access to fuel, specifically wood, by promoting woodlots near and around homesteads and generally in the command area (see Impact O26).
- Rural electrification, initially for domestic lighting and the recharging of mobile telephones (see Impact O26).
- Careful access and safety planning if settlements are developed for irrigation (see recommendation on this topic at Impact C17).
- Upgrade local health services (see Impact O33).
- Ensure that women are fully represented in WUA decision-making by establishing and enforcing structural mechanisms to guarantee this (see Impact O36).
- Enhance the capacity of the Woreda Women's, Children's and Youth Affairs Office so that it is able to actively support and protect the most vulnerable and abused women, *or* enhance the PSP contractor's social capability to fulfil the same functions during project start-up.
- Establish microcredit programmes specifically for women, linked to gender-focused technical extension (for example, for very small scale enterprises such as homestead poultry production, or a small shop or trading point (*souk*), or a village phone rental service; see Impact O39).
- Establish a major programme of adult literacy classes specifically for women (see Impact O39).

Residual significance: if these measures are implemented effectively, the positive impacts will be dramatic (with additional benefits to the GoE in terms of public relations in the aid and development sector).

5.4.8.3 Impacts of Transformation of Livestock Husbandry System

Impact O25: the project will (a) reduce the total area of communal grazing, and (b) probably increase the demand for labour for livestock husbandry, with knock-on effects on livestock numbers.

Analysis: livestock, especially cattle, are essential for the existing mixed farming system and provide many practical, productive, economic and cultural services. Cattle numbers are high due to the need for oxen for cultivation. However, existing feed resources are inadequate and being further degraded by unpalatable species, livestock health is poor and productivity is low. The project will reduce the area available for communal grazing in the command area due to direct land take for the infrastructure and the associated conversion of some grazing lands to farmland (see 5.3.4.4). Year-round cultivation will require all livestock to be controlled - free-grazing is not permissible in unfenced cropped areas (fencing is not practical on the scale of the project). The consequences of reduced grazing and exclusion from dry-season fallow or post-harvest fields for livestock herding will be significant: stock will have to be much more tightly controlled, and will have to survive on even fewer common property grazing resources. Labour demands for herding will increase.

The project proposes fodder production on irrigated land to offset the loss in grazing resources, mechanisation as an incentive to reduce cattle numbers, and various measures to enhance livestock productivity. Additional feed resources will be available from the increased volumes of crop residues. This amounts to transformation of the livestock husbandry system. Fodder production implies a cut and carry system with animals tethered at the homestead. Cut and carry has a considerable labour demand which (in other countries) is often delegated to women and children. Large-scale mechanisation is unlikely within the first decade of the project, so farmers will wish to maintain the usual numbers of cattle despite the reduction in grazing resources and changed herding requirements.

The period of transition to the new system will be one of considerable challenges for PCA households, specifically in terms of (i) labour demands, and (ii) ensuring the availability of draught animals for cultivation exactly when necessary.

Mitigation options:

- Establish a major livestock component from the earliest years of project operation (see Impact O38).
- Consider offsetting the loss of grazing land to project infrastructure by allocating the land between the dykes along the main rivers to pasture (this land will be flooded frequently).
- Support the kebele administrations in identifying and marking livestock corridors through the fields, to assist herding efficiency between villages and grazing land.
- Construct watering points for livestock within irrigation canal system.
- Establish and fund a formal mechanisation component within the project (see Impact O38).

Residual significance: if the measures identified above are implemented, there will still be a substantial transition period during which there will be major challenges for most PCA households.

5.4.8.4 Inadequate Fuelwood and Energy Supply

Impact O26: (a) continuing lack of fuelwood supplies will (i) maintain high labour demands on women for collection and processing of alternatives (manure, crop residues), (ii) maintain the associated smoke-related health impacts, and (iii) maintain the existing pressure on increasingly scarce wild wood resources; and (b) the continuing absence of electricity will prevent rapid or efficient uptake of the project's economic and developmental opportunities.

Analysis:

(a) PCA residents will continue to cook and heat their houses using locally-available fuels for the foreseeable future (gas and electricity are not relevant technologies under the prevailing circumstances; kerosene cooking might be, but only if incomes rise significantly and a supply system emerges at village level). At present the fuels are dried manure, eucalyptus (directly, or as charcoal), wild-gathered sticks and crop residues (see Section 4.4.5.8). Collection of these fuels is a major task for women on a daily basis. Combustion of these fuels results in significant smoke hazards within houses. Use of manure for fuel diverts this material and its nutrients away from fields. Collection of sticks from the surrounding hills contributes to further degradation of the remnant scrub forest.

(b) Electricity is not available in the PCA and no firm plans to connect all kebeles to the grid have been identified. Electricity is essential for many aspects of operating a commercial irrigation scheme, for the administration, for education, health and other services, for improved quality of life in households, and for business in general.

Mitigation options:

- Establish a project component to promote fuelwood plantations and other trees around villages and/or along linear structures such as canals and service roads[94].
- Promote the use of low-smoke fuel-efficient stoves (e.g. the modified *Mirt* stove series being promoted in the region with assistance from GTZ; see Megen Power Ltd. (undated) for review).
- Install solar lighting systems (using diodes) in the kebele headquarters, with a plan to roll this out to homesteads as incomes increase.
- Install solar recharge points for mobile phones, run by community members (micro-enterprise) (many benefits, including access to market prices by farmers).
- Work with EEPCo and Dembia Woreda administration to create a firm plan to electrify the command area.

Residual significance: if fuelwood supplies are increased, and if electricity is brought to the command area, the impacts will be highly positive.

5.4.8.5 Changes to Access Routes

Impact O27: (a) the entire scheme depends on access to the main road network for the supply of goods and services necessary as inputs and, even more importantly, for timely export of produce to markets; interruption of the new road network's shortest link to the outside world (the proposed gravel road to Guramba village and thence to Kola Diba and the paved road network) due to erosion or flood damage would have an immediate impact on the scheme's success; (b) all-season internal access will be essential but some of the roads may not be built to all-weather standard, especially the community link roads; and (c) the many new channels will provide barriers to human and livestock access between crossing points, although the new service roads will facilitate movement in the wet season.

Analysis:

(a) The project will be linked to the main road network in two locations, firstly along the existing fair-weather track from Kola Diba southwards to Guramba, entering the command area at the end of the main canal near Guramba Bata Church, secondly along a new all-weather access road from the gravel Kola Diba - Gorgora road via Wawa Farm, crossing the main canal near the pumping station. The shortest and quickest access to external markets will be the road through Guramba. If this is cut for any reason, vehicular traffic (but not donkeys) will have to travel via Wawa, a major detour. It is essential that both the access roads are well maintained, as well as the Kola Diba - Gorgora road. Construction and maintenance of the crucial Guramba - Kola Diba link is understood to have been delegated to (future) the Upper Megech Gravity project. Delayed construction of this road will have a significant effect on project operation and benefits; it is important that construction of this road is included in the MPIDP construction package.

(b) The FS suggests that "... the road surface[s] could be paved with natural gravel, where necessary for effectiveness during the wet seasons. Otherwise the surface may be natural soil surface." (MPIDP FS Exec. Summary, p37). In the Detailed Design Report all the project roads will be gravelled, but the 5.45 km of "Community Roads" "expected to be built by the community and be only dry season roads". It is essential that all roads, and especially the two key access roads (above), are built and maintained to all-weather standards in order to enable full agricultural operations (inputs, outputs, inter-kebele access, travel of extension and health agents etc.). This implies a gravel running course. The "natural soil surface" is not appropriate as a road surfacing material in this location. In addition, it is not clear how "the community" will provide the funds, labour, knowledge and equipment to build the Community Roads.

(c) The canals and larger drains will present a significant physical barrier to livestock moving from homesteads to and from the grazing areas, and necessitate adjustments to daily movement patterns. It is likely that livestock will cross the smaller channels at many locations away from bridges or culverts, with associated damage to canal banks.

94 A similar proposal is made in the draft Feasibility Study of the adjacent Robit scheme (Halcrow-GIRD 2010).

Mitigation options:

- Designate *all* the project roads as all-weather, and design and build them to this standard as part of the construction contract.
- Include upgrading of the Guramba to Kola Diba track to all-weather standard in the construction contract.
- Ensure that the O&M contract includes road maintenance from the PCA as far as the Kola Diba - Gorgora road for both the access roads.
- Provide an adequate number of channel crossings for pedestrians and livestock, in detailed consultation with affected stakeholders at kebele and household level (see Impact C19).
- Consider including east-west connections into the project as a long term strategic access plan, specifically road crossings of the old and new Megech Rivers.

Residual significance: major positive, if adequately mitigated.

5.4.8.6 Inequitable Distribution of Benefits

Impact O28: the project may create "winners" and "losers", increasing the economic distance between those obtaining most benefits and those obtaining least, or, in the worst case, increasing impoverishment amongst those unable to cope with the new conditions.

Analysis: possible losers are (i) female-headed households, who may not have been treated fairly during the land reallocation process due to their social marginalisation, and/or may be landless in any case, and/or may not be able to provide the skills and labour needed to manage their land and livestock under the new conditions; (ii) farmers growing similar crops under rainfed conditions in the areas surrounding the PCA, who may suffer price competition in the markets (see Impact O29), (iii) fishing families, if fish stocks are affected by the changes in habitat associated with the project (see Impacts O20 - O22), and (iv) individuals adversely affected by new technologies, especially pesticides (see Impact O13). Note that although land reallocation is likely to disrupt some existing mutual support networks, such as the tradition *edir* or *equb*, over time these should become re-established.

Possible winners will include, in addition to most farming households, (i) existing landless individuals (mostly the young) who will be able to benefit from the increased demand for agricultural labour and employment in the various service industries which will be required, (ii) women able to develop micro-enterprises (which assumes that the necessary support mechanisms are provided), and (iii) households using the lakeshore resources, if individuals from the households become involved in a benefit from the proposed lakeshore restoration scheme (see Impact O19).

This analysis assumes that the scheme will continue to function as a small-holder operation. If farms are consolidated and allocated to larger farmers or investors, the benefits and equity picture will change significantly.

Mitigation options:

- Special attention to women during the land reallocation process (see Impact C16).
- Special programmes and support for women during project operation (see Impact O24).
- Special attention to the protection of fish habitat (wetlands and rivers) and water quality (see Impacts O20 and O22).
- Special attention to pest management (see Impact O13).
- Special attention to the development of farm to market links, to promote high value import-substitution and niche export crops which will not compete with local produce (see Impact O29).

Residual significance: if the measures noted above are implemented effectively, the risk of impoverishment of any particular groups will be minimised and the project's benefits maximised.

5.4.8.7 Reductions in Prices due to Over-supply of Crops

Impact O29: increases in production, if sold onto local markets, will reduce prices with two consequences: (i) adverse impacts on rain-fed producers of the same commodity, and (ii) creation of disincentives to production (see also Impact O40).

Analysis:

(a) Due to market inelasticity, the increased production of produce for domestic markets from the command area is likely to affect the prices and saleability of produce from rain-fed areas nearby, with potentially significant negative impacts on some rain-fed producers. This will apply, in particular, to perishable crops subject to damage during transport such as tomatoes and some other fresh vegetables. Problems of this nature are already being experienced in Fogera Woreda, where informal irrigation and vegetable production has spread rapidly in recent years (Akalu Teshome *et al.* 2009).

(b) As pointed out in the 2007 Market Assessment Study, the reduction in prices could also drive the original (project) producers out of supply (Langmead *et al.* 2007, p64). Some producers on the Koga project are experiencing similar problems.

Market opportunities are seen in (i) import substitution, e.g. for some oil crops, rice, and possibly wheat, and (ii) export crops, especially to surrounding countries for which Ethiopia has a comparative advantage in production (sesame, chickpea, haricot bean, Niger seed (*noug*), faba bean, lentil, soybean, ginger, other spices).

Mitigation options:

- Manage the scheme to focus on (i) import substitution, and (ii) export crops.

Note: this is already in process, with Operational Action Plans for pulses and oilseeds in the early stages of implementation.

Residual significance: too many variables to predict.

5.4.9 Health

5.4.9.1 Extended Exposure to Malaria

Impact O30: malaria is endemic in the area and a major cause of disease and death. The project is likely to change the pattern of malaria infections during the year, with an extension into the dry season (see Rapid Health Appraisal at Annex 7).

Analysis: permanent (year-round) malaria is less dangerous than short, intense seasonal transmission, but malaria will continue to have a very high impact on human health, especially for children. Health interventions are essential to ensure that the project's social and economic objectives are reached, and reducing malaria morbidity and mortality in the region is a battle to be fought every day for a very long time.

Mitigation options:

(a) **Spraying**: reduction of the Anopheles population by repeated house spraying with residual insecticides (DDT, more recently some of the pyrethroids) is not realistic. Nowhere in tropical areas has a long-term result been obtained by this method. This is due to (i) changes in mosquito behaviour and in insecticide effectiveness, (ii) the need to repeat the spraying one or two times every year in all houses for many years, and (iii) the cost of such measures.

(b) **Bednets**: reduction of contacts between humans and Anopheles by the use of impregnated bednets is useful. This has been proved to result in a reduction of the incidence of malaria. Together with efficient health facilities and health education, the general result of mass use of bednets, preferably impregnated with a long lasting insecticide, is a dramatic decrease in malaria morbidity and mortality. Long lasting impregnated nets (LLINS) were widely distributed in Amhara State some years ago. However, the bednets are fragile and do not last more than two or three years. Consequently, at present they are not available for each individual in all households. Moreover, they are not easy to use in houses without beds, and not all local residents are convinced of their effectiveness against malaria.

(c) **Environmental manipulation**: malarial mosquitoes breed in stagnant water, therefore steps should be taken to minimise stagnant water especially in and near settlements. This is very difficult in irrigation schemes, especially when irrigation and drainage channels are constructed through settlements.

In view of these challenges, the probable change in malaria incidence patterns caused by the project should be managed by four specific mitigation actions (below), together with more general health-related actions (see Impact O33):

- Firstly, increased coverage and use of bednets (target - 100% of population) by a large and repeated distribution of LLINs, together with (i) training of the population in their use, (ii) monitoring of the results, and (iii) increased awareness of the importance of rapid, accurate diagnosis and treatment. This action has to be developed with strong involvement of the responsible health workers.
- Secondly, "hands-on" supervision and training (practical "professional development") of local health workers by a physician specialised in malaria, its clinical and biological diagnosis, its treatment, and its management in rural areas.
- Thirdly, design and maintenance of all irrigation and drainage channels so that flows are more than 0.1 m/s and emergent vegetation is removed.
- Fourthly, exclusion of settlements from irrigation development (see Impact C17).

Residual significance: highly positive if effectively implemented.

5.4.9.2 Increased Risk of Schistosomiasis

Impact O31: (a) Intestinal schistosomiasis is endemic in the area. The project has the potential to increase the risk of infections by creating additional habitat for the snail vector, increasing exposure of the population, especially children, to water, and increasing opportunities for completion of the parasite's life cycle from humans to snails (channels in and near settlements). Medical opinion considers this the most important hazard to public health associated with project operation. (b) Urinary schistosomiasis is not present, but could be introduced.

Analysis:

(a) The increase in contact between humans and still or stagnant water will probably lead to a more intense transmission of S. mansoni (intestinal schistosomiasis). These contacts will be most frequent at the level of the tertiary canals and during the distribution of water onto plots. The new, permanent water bodies (canals and drains) may be favourable snail habitat and create a snail outbreak; if the snails are infected with Schistosoma, transmission could increase significantly.

(b) At present, urinary schistosomiasis is not reported in the proposed irrigation areas. Despite Bulinus snails being present in some ponds or puddles, the particular strain of snails and possibly also the environmental conditions do not allow the development of S. haematobium. However, changes in the environment, particularly the presence of slow moving water during the warm and dry season, could lead to the appearance of new strains of Bulinus receptive to S. haematobium. Consequently an outbreak of urinary schistosomiasis is possible, but unlikely.

Mitigation options:

(a) Environmental management: reduction of snail populations by activities such as drying out and cleaning canals (environmental management) is probably not realistic since the snails will be present in the tertiary canals and drains, and it is extremely difficult to be effective in channel sanitation at this level: draining the channels and cleaning all the aquatic vegetation have to be done every two months; this is an excessive work load for farmers; and if dried out the canal banks will crack.

(b) Latrines (to break the transmission cycle): coercive measures to make the population use latrines are not effective. Without any obvious personal advantage of latrine use individuals will prefer to relieve themselves behind bushes, in the fields and near water. Only general education and social change can alter this, over the long term.

In view of these challenges, and in relation to the probable increase in schistosomiasis transmission, one specific mitigation action is recommended:

- Repeated mass treatment of local residents against adult *Schistosoma* worms, using a drug such as praziquantel. The aim would be to treat all the population every six or twelve months. This treatment is cheap, well accepted because it is free of side effects, and effective. With repeated mass treatments the incidence of new *S. mansoni* infections does not decrease, but heavy infections disappear. Each individual tends to be infected with a fewer and fewer parasites and will have reduced or no clinical symptoms, a major benefit. Urinary schistosomiasis is also treated by praziquantel.

  Note that in practice this should be combined with mass treatment for helminth infections (see Impact O32 (a)).

Residual significance: highly positive, if mass treatment is effectively implemented.

5.4.9.3 Changes in Other Diseases

Impact O32: operation of the project is likely to change the incidence of some other diseases and causes of injury, ill-health and death. Some of the changes will be positive, others negative unless mitigated.

Analysis:

(a) **Helminths**: soil-related helminth larvae use wet soils and plants for an obligatory part of their lifecycle. The presence of permanently moist soils year-round and farming activities in the irrigated plots will increase the probability of human infection by hookworms through the skin of feet and legs. The transmission of Ascaris and other helminths will increase if contaminated vegetables are eaten without cooking (for example, raw vegetable such as salads or tomatoes), but at present these are not traditional foods. In summary, risks of infection by soil-related intestinal helminths will increase as a result project implementation.

(b) **Leishmaniasis**: the sandfly vector is present around both command areas in dry, rocky habitats with bushes. It does not favour wet, cultivated farmland, so operation of the project should not by itself lead to an increase of numbers of the vector or in Leishmania transmission.

(c) **Dracunculiasis**: irrigated areas are not favourable places for dracunculiasis transmission. Copepods are present but not the other elements of the parasite's lifecycle; human beings are not carriers of the parasites, and usually humans do not usually use irrigation water as drinking water. However, the future situation with respect to drinking water in the command area is unclear: no firm plans have been identified for improved provision of safe domestic water supplies (see Impact O34).

(d) **Yellow fever and Dengue**: mosquitoes of the genus Aedes, the vectors of yellow fever and dengue virus, do not use canals or puddles as breeding places. The larvae need small natural or man-made containers of clean water for their development. The irrigation schemes could lead to an outbreak of these diseases only if places for the larvae - for example, abandoned tyres or empty cans - are present. At present the very low level of money income of the peasants and consequently their low consumption of manufactured products does not favour such waste close to homesteads since such resources are re-used or recycled rather than dumped. This may change in future as incomes increase.

(e) **Human African Trypanosomiasis**: the sleeping sickness vectors, tsetse flies, are not present on the Ethiopian plateau. The local changes in the environment of the command areas caused by irrigation and drainage will not create favourable habitat for the reproduction of these flies, which need crumbly soils, high and dense vegetation, and high temperatures.

(f) **Onchocerciasis**: this disease is not reported from the Ethiopian plateau despite many natural streams with fast-running water. The blackfly vectors are not present. The slowly flowing water in the irrigation canals will not be favourable habitat for the larvae.

(g) **Diarrhoeas**: at present these are frequently observed in the poor rural population living in the command area. The presence of more water during a longer period of the year as a result of irrigation is unlikely to cause any change in the incidence of diarrhoeas. The incidence will only increase or decrease as a result of changes in the general level of sanitation, especially access to safe water for drinking and cooking, personal hygiene, the management of faeces and the storage and preparation of food. An analysis of reasons for the failure of previous sanitation and hygiene projects in Ethiopia and a new Country Strategy based on changing behaviours based on ethnographic investigation is given in WS Atkins Int. et al. (2005).

(h) **Poliomyelitis**: this is present in some parts of Ethiopia but at a very low level. Control of the disease is carried out by mass vaccination. The Ethiopian public health system is effective in undertaking large, repeated vaccination campaigns. Because there is no relation between the rate of transmission of poliomyelitis and the quantity of water in farmland, current rates of polio transmission are unlikely to change as a result of project operation.

(i) **Hepatitis A**: as with polio, this disease is not related to the quantity of water in the environment. Its incidence will decrease only with large and repeated mass campaigns of vaccination, together with better domestic water supplies, sanitation practices, hygiene and food preparation.

(j) **Trachoma**: this results from Chlamydia transmission by flies and dirty hands; its incidence will not be directly altered by operation of the irrigation and drainage scheme. The incidence of trachoma will decrease if contacts between human beings and flies are reduced, and if general hygiene standards improve, including use of latrines. The use of stables for livestock could contribute to fly reduction, but it is not realistic to expect this under the conditions of the project area. However, the project is likely to alter livestock husbandry practices and numbers through reducing the area available for grazing and fodder production, and by mechanisation. Over the longer term this might contribute towards reduced fly numbers, but no early changes in trachoma incidence should be expected.

(k) **Acute respiratory tract infections (ARTI)**: these are largely a consequence of bad housing conditions, cool temperatures, the frequent presence of smoke in houses, and the lack of warm clothes. The irrigation project will not, by itself, reduce the incidence of ARTI. Reduced ARTI will only be achieved through the improved living conditions associated with the higher incomes, better education, and improved health services which, hopefully, will result from the project.

(l) **Pulmonary tuberculosis (TB)**: the same environmental conditions that favour ARTI (housing, temperatures, smoke, clothing), human behaviour, and also the presence of AIDS, favour the transmission of pulmonary tuberculosis. The prevention of new cases of TB requires fast diagnosis and efficient treatment, both of the sick persons and of asymptomatic carriers of the tuberculosis bacteria. The irrigation project will not, by itself, reduce the incidence of TB.

(m) **STDs and HIV/AIDS**: as noted under Construction (Section 5.3), sexually transmitted infections and HIV/AIDS are not linked to the environment but to human behaviour. The consequences of operation of the scheme for sexual behaviour of the population are hard to predict. Improved general education and specific awareness of STD and HIV/AIDS prevention techniques can both be expected to improve, in line with a general increase in living standards. At the same time, increased economic activity resulting from the scheme, especially at market centres, is likely to result in more bars and prostitution in these locations. Of particular importance for sexual disease prevention is the degree to which women are socially and economically empowered by the project.

(n) **Zoonoses**: the incidence of zoonoses is likely to decrease as animal health increases, in line with the projected positive transformation of livestock husbandry.

(o) **Malnutrition**: logically, malnutrition should decrease with an increase in food production and an improvement in family incomes and food security. However, in some irrigation projects elsewhere in Africa an increase of chronic or acute malnutrition of infants, children or adolescents has been observed after starting irrigated cropping (Brun 1991; Mwadime et al. 1996). This is due to the wish of farmers to maximise incomes by giving up traditional crops and growing and selling cash crops instead, and also to difficulties in the management of farm budgets and un-manageable increases in family labour demands.

(p) **Accidents**: the project will create roads and road traffic where none existed and will promote agricultural mechanisation. Consequently accidents associated with vehicles and agricultural machinery can be expected.

(q) **Pesticide poisoning**: the project will intensify agricultural production, a process typically associated with increased use of pesticides (insecticides, herbicides and fungicides, as well as other categories such as rodenticides). Many of these chemicals are toxic to humans as well as to the target and non-target species. The system for controlling pesticide use in Ethiopia is weak (see Annex 8, Pest Management Plan). Consequently the risks to human health of pesticide use during project operation are high. Exposure could be through a number of different routes, especially (i) occupational (during handling, mixing and application), (ii) accidental (from contaminated clothes, re-use of containers etc.), and (iii) through consumption of residues on food crops.

Mitigation options:

(a) **Helminths:** mass treatment of local residents by drugs such as pyrantel or albendazole will cure intestinal worm infections. These drugs are effective, cheap, and well accepted. Repeated mass treatments do not stop the transmission of soil-related helminths, but heavy infections with important consequences for health will become absent or rare in the treated population.

(g) **Diarrhoeas:** the incidence of diarrhoeas in the beneficiary population in the command area will not decrease without specific actions. In addition to improved general education, and assuming continued curative care of severe cases by health workers, these are:

- Firstly, intensified health education (especially hygiene) for disease prevention, as well as home treatment.

- Secondly, supply of safe water for domestic consumption. This is critical, since water from surface sources and from shallow groundwater is generally not safe. Piped supplies could be provided from safe or treated sources upstream, but this would be extremely expensive. Deep drilling and pumping is also expensive, and may be ruled out by salinity. The only realistic options appear to be use of shallow groundwater or surface water, but in both cases treatment (disinfection) is essential. This subject requires additional study to develop practical, cost-effective and sustainable solutions prior to design and roll-out across the command areas. Whatever systems are adopted, they should be managed locally and involve a fee, however nominal, to ensure local ownership.
- Thirdly, identification and then promotion of appropriate latrine systems; this will require experimentation with different latrine technologies to identify low-cost culturally-acceptable systems capable of effective operation in the high-groundwater command areas (i.e. some type of dry composting toilet).

Note: MoWE has major initiatives in place to rapidly implement water, sanitation and hygiene (WaSH) programmes in order to achieve the Millennium Goals. The Bank is supporting the Ministry with computerised monitoring and evaluation management information systems (M&E-MIS) which will provide access to WaSH data and information at all levels, down to Woredas. This will support the multi-stakeholder coordination efforts already in place under MoWE's Research-inspired Policy and Practice Learning in Ethiopia Programme (RiPPLE).

(j) **Trachoma:** the incidence of trachoma in the command area will decrease if general hygiene improves, if the swarms of flies are reduced, and with effective treatment of cases. Considering the lack of any realistic prospect of reducing fly numbers, the following action against trachoma could be taken in the command area:

- Awareness and prevention activities by health workers, especially in locations far away from health facilities, through an extension of the SAFE programme.

(k) **ARTIs:** acute respiratory illnesses are difficult to prevent. They will probably persist at the same level for many years. Actions that will assist in reducing ARTIs and that could be taken as part of a health programme associated with the project include:

- Reduction of indoor smoke by promoting household ventilation, smokeless / fuel-efficient stoves, solar cookers and gas, biogas or kerosene stoves.
- Improving the ARTI diagnosis and treatment capability of health workers.
- Improving the availability and quality of drugs, especially antibiotics, in health facilities or other sales outlets, at a price compatible with local income levels.
- Improving physical access to health facilities. This is very important, both for users (e.g. pregnant women, elders) and for health workers, as well as for medical supervisory staff. At present access is good to facilities near paved roads on the edge of the command area, but very difficult to facilities inside the scheme because the lack of roads and all-weather tracks.
- Promoting the use of increased household incomes resulting from the project for better clothes, shoes, bedding, and (eventually) better housing (adult education in "domestic economy").

(m) **STDs and HIV/AIDS:** given the link firstly between irrigation and cash availability to households, and secondly between increased cash availability and increased STD transmission, it is important to integrate appropriate responses into the project as early as possible. Prevention of STDs and AIDS is strongly linked to behaviour and consequently to education levels. It depends also on gender relations, the balance and practice of power between men and women and between elders and young people. It is obvious that both general and health education are the best ways to prevent these diseases. Treatment of STDs is also useful to prevent infection of partners and to reduce the risk of co-infections by various pathogens. Actions to manage the STD and HIV/AIDS risks associated with the project during operation are:

- Firstly, design and implement information, education and communication (IEC) campaigns concerning STDs and AIDS.
- Secondly, train health workers to be more effective in the diagnosis and treatment of STDs
- Thirdly, consistent with the national HIV multi-sector approach, devise mechanisms to empower local administrations to develop advocacy for improved access to HIV counselling and testing, and STD prevention and care.

Note: as part of the social interventions around the project, the issue of HIV/AIDS risk being a possible consequence of poverty reduction should be introduced, and the responsibility of local authorities in controlling it should be emphasised. Sensitisation to health and HIV issues is regarded as critical for long term sustainable project and socio-economic outcomes, and should be resourced accordingly…

- Fourthly, establish and maintain appropriate surveys.

(o) **Malnutrition:** the project has a goal of increasing household-level incomes by intensification and commercialisation of agriculture, especially crops. Malnutrition is closely tied to general income levels, as well as to the management of household budgets and the income from crop and other product sales, to mother and child health and to education. It is important for farming households to retain enough products for domestic use as well as for sale and to use these well, especially in accordance with the needs of infants and children in terms of energy and proteins. Commercialisation of agriculture should not be a reason to abandon cereal cropping or to sell all the harvest. Poultry and sheep are important for access to animal proteins. The health education programmes now offered in the Health Posts are already showing signs of changing attitudes. These should be continued. To achieve the national socio-economic development objective of reducing malnutrition and avoid the low but real project-specific risk of reduced household food security due to sale of crops, the most significant actions that could be taken in the command area would be:

- Firstly, general education, especially female literacy, to enable residents to obtain and absorb further information. This will progressively result in better understanding by mothers of child nutrition.
- Secondly, integration of nutrition-related issues (household resource management and food preparation) into the health education and awareness packages recommended to accompany project implementation. Specific attention should be paid to gender issues in nutrition.
- Thirdly, promote homestead gardens and livestock micro-enterprises (e.g. poultry), specifically to augment and enrich household food supplies as opposed to exporting food from the command areas.
- Fourthly, implementation of an appropriate nutrition monitoring programme.

(p) **Accidents:** the improved access associated with the project will (i) improve health service provision locally (better health posts with more equipment and higher skills), and (ii) facilitate transport of patients to health facilities outside the PCA. However, physical and economic access to emergency care will remain a challenge for most command area residents. Recommended actions to reduce accidents and improve emergency care include:

- Skills training in use of all new tools and machinery.
- Awareness for households (especially women, elder children) of potential dangers from agricultural equipment, traffic, and (if relevant) canal siphons and under-passes.
- Inclusion of a mandatory health insurance premium in the water user fee to cover at least (i) costs of travel to emergency care facilities, and (ii) emergency treatment, for all household members.

(q) **Pesticide exposure:** a significant number of actions will be required to prevent human pesticide exposure during project operation. These are outlined in the Pest Management Plan at Annex 8. See also Impact O13.

Residual significance: all these health impacts can be managed, and if this is done effectively the results will be highly positive; nevertheless, it is impossible to prevent all accidents and these will continue to occur, with a consequent residual adverse impact on those individuals affected.

5.4.9.4 Low Health Status of Beneficiaries reducing Project Benefits

Impact O33: continuing low standards of health in the project area may prevent the project from reaching its objectives.

Analysis: existing levels of health in the project area are very low; the disease burden is very high; life expectancy is low; and women suffer from very high levels of maternal mortality (Ethiopia is finding it hard to make rapid progress towards Millennium Development Goal 5: Improve Maternal Health (MoFED 2008)). Even if additional health resources are dedicated to managing those diseases specifically associated with operation of the project (see Impacts O30, O31 and O32), this will still leave many other serious diseases active in the local population. The physical and financial stress of coping with disease diverts household resources from productive tasks, and is highly likely to continue to be a major factor in reducing labour productivity as well as quality of life for project area residents.

Mitigation options: mitigation of some health risks can be achieved (i) by **prevention**, through design changes or changes in operation practices to alter environmental parameters such as groundwater levels, thereby preventing disease transmission, or (ii) by **treatment**, curing infected patients and, for communicable diseases, reducing transmission frequency.

Although outbreaks of disease can appear rapidly, changes in knowledge, attitudes and behaviour are slow, but they are essential to achieve sustainable improvements in human health. Sustained improvements in health will only be achieved by major changes in health-related knowledge, attitude and practices (KAP) by local residents.

Worldwide, achieving changes in KAP is very difficult, especially in rural areas with a very poor and uneducated population. Therefore sustained health improvements will require:

- Long-term investment in social services (education, health) with special attention to women's issues.
- Improvements in both community infrastructure (roads, electricity) and domestic infrastructure (housing, water supply, sanitation).
- Higher incomes.

Residual significance: if additional health resources are provided to the project area to reduce the burden of disease on a sustained basis, the residual impact will be highly positive; if these measures are not implemented, the results will be measurable in continued disease burdens and preventable deaths.

5.4.9.5 Inadequate Water, Sanitation and Hygiene reducing Project Benefits

Impact O34: in the absence of improvements in access to safe water for domestic use, major labour demands on women and continuing high avoidable disease burdens will continue; the lack of access to clean water will also prevent progress towards improvements in hygiene and changes in sanitation practices; in combination, these constraints are likely to prevent the project from achieving its developmental goals due to diversion of labour and ill-health.

Analysis:

(a) Obtaining water is a major demand on women's time; the water obtained is unlikely to be bacteriologically safe and in some locations is reported to be saline; during project operation surface water will be available in irrigation canals (Photo 5-6) but may be contaminated, especially by livestock; without safe water few improvements can be made to hygiene. No accelerated programme for provision of safe water in the PCA has been identified. **The provision of safe water for domestic use is considered by the ESIA consultant's social investigators - and by the regional Bureau of Women, Children and Youth Affairs - to be the most critical issue facing the project area**.

(b) Current sanitary behaviours contribute to rapid transmission of many diseases and are detrimental to dignity, especially for women; latrine use is minimal; latrine designs are unsuitable for high groundwater areas, being liable to flooding and unpleasant to use.

Photo 5-6: Washing and swimming in new canal in Koga Irrigation Project

Mitigation:

- Install cemented wells with hand pumps in all population centres in the PCA so that nearly all households are within 10 minutes walk one-way to safe water (~30 minutes round trip) (see also Impact O32). Notes: (i) wells are likely to need to be about 15 m deep to minimise chances of contamination; (ii) a small cement-ring industry has just started in the village of Abalign in Achera Mariam kebele; (iii) in accordance with normal good practice, for sustainability all wells should be under local control and managed by a designated individual accountable to the community. Small user fees are recommended to instil a sense of ownership of the service.
- Establish a water quality laboratory in Kola Diba together with a regular programme of water testing (in addition to a building, furniture, equipment, consumables, and staff, this will require transport such as a motorcycle with a specialised rack for water samples).
- In the longer term, initiate a programme of rainwater harvesting using the metal roofs likely to become increasingly popular as incomes increase, together with appropriate low-cost above-ground storage tanks.
- After providing safe water, identify and promote appropriate latrine systems (see Impact O32).

Note: the Bank has significant experience in rural water supplies, both internationally and within Ethiopia. The advantages of adding water supply components to irrigation projects were highlighted in the Bank's Sourcebook for Investment in Agricultural Water Management (WB 2005: Box 5-1).

Box 5-1: World Bank Innovation Profile 7.1 - Rural Water Supply and Irrigation

Rural Water Supply and Irrigation

What is new? Simultaneous investment in drinking water supply and irrigation is rare, although it is often cost effective in reducing rich-poor gaps in income and health. Rural communities can operate systems using the same source of water for both small-plot irrigation and drinking water as income-generating businesses. The Mekong Delta Water Resources Project shows that a small investment in separate rural water supply hardware, funded through a subcomponent of a large water-resources or irrigation project, can also cost-effectively deliver benefits to the rural poor, especially to those living far from roads.

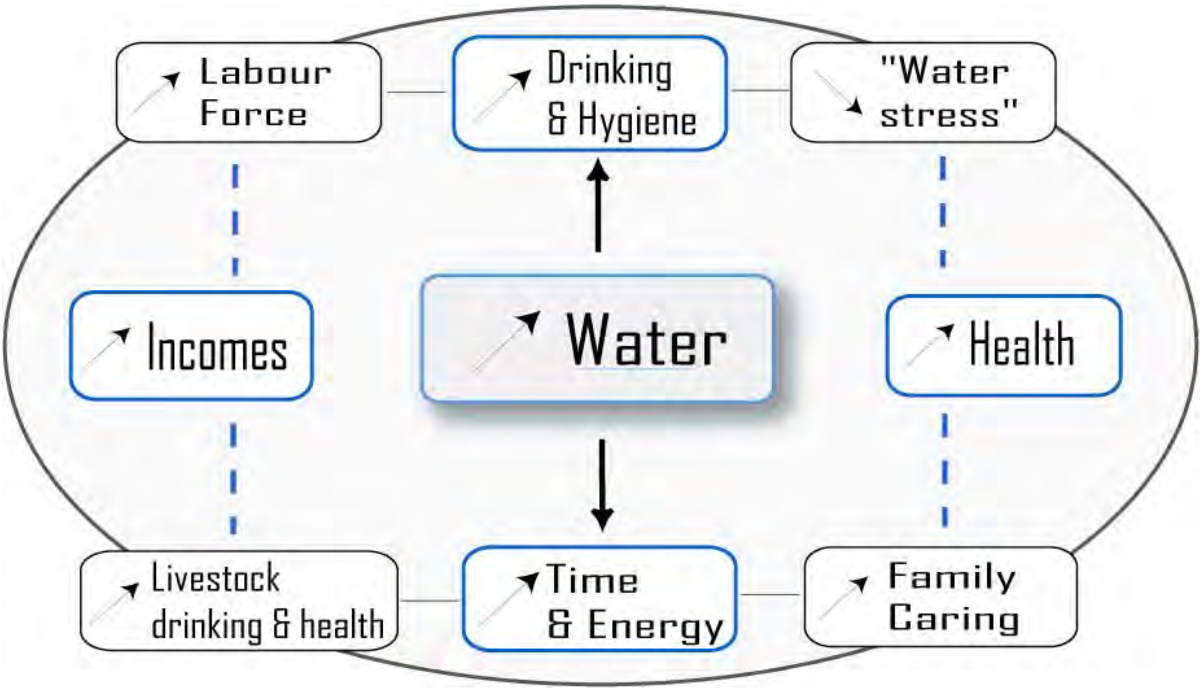
Issues For Wider Application

- *Small Investments Yield Great Benefit and are Worth the Extra Effort*
- *Involve Grassroots Entities.* These grassroots connections can mobilize small communities, and in this case, experience with the women's unions contributed to effective organization of awareness campaigns that reached individual women farmers with small group-based credits and training in hygiene.
- *Foster Interaction among the "Water Players".* Although they inhabited the same ministry, the "irrigation people" and the "RWSS people" interacted little. Project implementation brought interaction through meetings, supervision, and monitoring. Trust grew between these professional groups and between the central and provincial agencies dealing with water, which reinforced integrated water resources management.
- *Balance cost-recovery and poverty goals.* The goals of greater cost recovery and poverty alleviation had to be balanced because the target population lived in remote areas with little market access.
- *Synergies with irrigation development may be the key to the financial sustainability of RWSS.* Irrigation usually raises incomes with which to repay loans and pay O&M of domestic water supply.
- *Strengthening communication and collaboration between the professional communities.* In water supply and sanitation, water resources and irrigation, communication among all actors is key, both in-country and within the Bank. Funding mechanisms and budget provisions should be set aside for joint design and implementation. The RWSS toolkit for multisector projects provides useful support.

Source: Extracted from: WB (2005)

Residual significance: if these measures are implemented effectively, they will dramatically change the lives of women and children in the command area for the better (Figure 5-2); if not implemented, the continuing absence of easy access to safe water is likely to be a major constraint on reaching the project's agricultural objectives.

Figure 5-2: Safe Domestic Water: the Benefits



Source: Consultant

5.4.9.6 Safety Hazards

Impact O35: operation of the scheme will be associated with a variety of safety issues, most importantly road traffic, agricultural machinery and processes, and the presence of water.

Analysis:

(a) When operating, the project will generate motorised road traffic comprising occasional light 4WD vehicles, light trucks, buses, and a few motorcycles; the human and animal populations are not used to traffic, poor vision and hearing are relatively common, as is drunkenness, and there will be accidents. There is no effective ambulance service in the area.

(b) At present there is no agricultural mechanisation. Tools are very simple and well known (e.g. lightweight plough, hoe, sickle). The introduction of a much wider range of tools and equipment, including e.g. cultivators, threshing machines, and pesticide sprayers, will result in avoidable accidents until knowledge, attitudes and practice change to match the new technologies.

(c) Children are attracted to water (Photo 5-6), and the main canal siphon under the Dirma River will be particularly interesting. Unlike the cross-drainage siphons which are potentially lethal but short, anyone swept into the Dirma siphon would certainly be drowned. The trash rack which must be provided at the entrance to the siphon should be, if possible, child proof and escape-friendly. In the settlements, very small children will be attracted to the new water-filled irrigation canals, which will present a significant hazard and increase the stress level and work of mothers.

Mitigation options:

- Improvement of road safety requires a variety of actions, from training through improvements to roads and vehicles to enforcement; the most practical action to reduce accidents in the command area would be safety awareness campaigns in local schools.
- Avoidance of agricultural accidents can be improved by appropriate training through FTCs (see Impact O32).
- Provide safe access points to lined canals (requires detailed local consultation to identify the most useful locations) (Photo 5-6).
- The Dirma River siphon trash rack should be designed so as to (i) prevent even small children from being admitted to the siphon entrance, and (ii) angle the bars so that any person (or animal) swept against them will have some chance of escaping to the surface (it is understood that this has been done).

- Construction of channels through settlements should be avoided (see Impact C17).

Residual significance: minor adverse (accidents, by definition, are not fully mitigable); significantly adverse for those involved in accidents.

5.4.10 Institutions

5.4.10.1 Ineffective Operation of WUAs

Impact O36: the scheme depends on effective, coordinated management of water at the level of tertiary canals and below; if the organisations established for this purpose are not effective, the scheme's benefits will be greatly reduced and the risk to soil quality increased.

Analysis: responsibility for operation and maintenance of the entire scheme below the secondary canals will be the responsibility of irrigation water user associations (IWUAs or WUAs in this report). The FS recommends establishment of WUAs based on tertiary canals as the organisational unit (see Chapter 7, Alternatives). The basic organisational unit will be a Water Users' Basic Unit (WUBU) covering 16 ha (i.e. 16 - 64 farmers, depending on the degree of consolidation of plots). It is proposed that several (5 to 10) WUBUs join together to for a Water Users' Cluster (WUC), and in turn 5 to 10 WUCs join to form a WUA. On this basis each WUA will cover some 400 to 800 ha, and there will be 7 to 14 WUAs within the PCA.

The WUAs and their subsidiary units and members will be responsible for all system O&M below the secondary canals. This is a major responsibility and requires a significant level of managerial and technical skills and physical resources (facilities and equipment). Since WUA membership will be compulsory, fees will be collected and in-kind contributions expected as well (maintenance of on-farm channels), the WUAs will need transparent procedures, democratic and inclusive election and governance mechanisms, bank accounts and bylaws. Women and affected livestock keepers must be fairly represented and have equal access to group support and services[95]. At present none of this exists, except for a traditional water users' system in Aberjeha Kebele and some small, informal groups in Chenker Cherkose Kebele.

The creation and training of the WUA organisations for the PCA is a major task and will require (i) enactment of the relevant legislation, (ii) significant social preparation, and (iii) intensive hands-on support and training at start-up and over the initial years of operation, and (iv) provision of facilities and equipment. The current proposal for scheme management sees the delivery of this programme as an additional responsibility of the construction supervision contractor, who will also operate and maintain the scheme to secondary level over the first 5 years. The contractor will require a deep understanding of local social dynamics as well as the more usual technical irrigation and organisational skills in order to have any chance of succeeding.

Failure, or delay, in operationalising the WUA system for on-farm management will result in inefficient use of water and poor system maintenance, with lower crop yields, wasted water, an increased risk of impeded drainage, groundwater rise and secondary salinisation, and significantly reduced project benefits.

Mitigation options:

- Provide the contractor responsible for WUA creation with sufficient resources to implement an effective, long-term intensive WUA support programme, including facilities and equipment as well as training.
- Accelerate WUA and sub-WUA establishment so that leaders and members can be involved in planning and construction of their systems from the earliest date (see flow chart for WUA establishment at Figure 8-2).

Residual significance: none negative, if effective.

5.4.10.2 Risk of Experimental Off-farm Management Model

Impact O37: the scheme depends on efficient operation and maintenance, (a) to supply water (via the pumping station and main and secondary canals and night reservoirs), (b) to drain the command area (off-farm and main drainage channels), (c) for flood control (maintenance of dykes), and (d) for other services such as WUA support and the collection and administration of fees. If the organisation established for this purpose is not effective, the system's benefits will be reduced.

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[95] The ESMF requires that "minority groups and pastoralists must have representation with the WUAs".

Analysis: Ethiopia has no experience of successful large-scale, modern smallholder irrigation[96] and the MPIDP is recognised to be a pioneering, experimental project. The proposed management model is understood to involve (i) the MoWE and its regional and woreda-level counterparts as owner of the pumping station and primary and secondary canal systems - and also the off-farm drainage system and the flood control measures, (ii) a private sector organisation paid by GoE to (a) operate and maintain the scheme to secondary canal level, (b) facilitate the creation of WUAs and provide support to them, and (c) to develop an "Entity" to eventually take over scheme O&M, (iii) Irrigation Water Users' Associations to operate the tertiary and on-farm irrigation and drainage systems and pay a fee for water to GoE to cover the operator's O&M costs, and (iv) the operator and MoARD and its regional and woreda-level counterparts as service providers, either directly or through commercial service and input organisations that will be established in the project area.

This arrangement reflects the acknowledged lack of operational capacity within MoWE / BoWRD for system O&M. However, it is experimental and carries many risks, particularly those relating to (a) cost recovery, (b) effective O&M of the on-farm systems (see Impact O36), and (c) the quality and availability of knowledge services and other inputs necessary for sustainable and productive irrigated agriculture (see Impacts O38 and O39). The experience, attitude and approach of the O&M contractor (the "PSP contractor") will be crucial.

In terms of logistics, it is understood that MoWE will provide the permanent offices for the PSP contractor. At present the plans are to situate these at Wawa close to the future pumping station. This will be convenient for supervision of the construction activities, especially of the pumping station, main canal and Phase 1 west of the Dirma River. However, in the long term, it would be much more efficient to locate the offices on the north side of the command area, around Guramba: this would reduce travel time and costs for management, inspections and training, greatly facilitate interaction with Woreda staff, and is on the natural shortest route to markets for command area producers.

Mitigation options:

- Review the planned location of the permanent PSP offices / compound to maximise long-term efficiency.
- Ensure that the O&M contractor's contract provides sufficient incentives and legal clarity to ensure effective performance.

Residual significance: none negative, if the off-farm management system operates effectively.

5.4.10.3 Inadequate Provision of Services and Inputs for Agriculture

Impact O38: commercial smallholder irrigation requires a large number of supporting services and inputs to be effective. At present the regional government's capacity to provide these services to the Dembia PCA is low, the private sector is weak and not well regulated, and no firm plans and budgets for the sustainable provision of all the required goods and services have been located by the ESIA study team beyond normal GoE and ANRS budgets and ENIDP Component 2 and 3. Consequently there is a high risk of slow take-up of the agricultural opportunities provided by construction of the project.

Analysis: the range and nature of the inputs and services required for efficient operation of the scheme are described in the FS, which emphasises the importance of technical support (see summaries at Chapter 2, Section 2.7 of this report). The requirements are large, including research (livestock, crops, soils), extension services and farmer training, seeds, fertilisers and pesticides, credit, mechanisation, crop processing and storage, links to markets and market information, and day to day advice such as water scheduling in relation to crop growth stages, soil moisture conditions and weather.

Government ability to deliver the required services is weak (see Box 5-2 for an example, an analysis of the extension system, as described in the MPIDP FS). Recognising this, Components 2 and 3 of ENIDP have been established to support and develop some of the services, and have initiated activities in cooperation with BoARD and ARARI.

[96] The Koga Irrigation Project has run into many problems and is not fully operational yet.

Box 5-2: Review of Extension System

Review of Agricultural Extension System

The government developed the Participatory Demonstration, Training and Extension System (PADETS), a modified version of the World Bank Training and Visit system, within the National Extension Intervention Programme (NEIP). PADETS focuses on direct involvement of farmers in planning, execution and evaluation of extension programmes. NEIP works to achieve the aims of ADLI.

Implementation of PADETS is based on the construction of five farmer training centres (FTCs), one per peasant association (PA). To date some three FTCs have been constructed in Dembia Woreda. Three development agents (crops, livestock, natural resource development), are assigned to each PA. Livestock-specific extension packages cover dairy production (comprising advice, crossbred heifers, selected native cows, and breeding bulls), meat production (advice, beef production, small ruminant production), poultry (advice, distribution of cockerels, pullets and day-old chicks, improved poultry feed), apiculture (advice regarding all three types of hives and their management), forage (advice, planting materials, hay production, and pasture management), and animal health.

The lack of mobility and fund shortages means that the essential regular field visits and training is incomplete. Extension links with support research centres are poor. The diagnostic skills of extension staff are weak and compromise identification and analysis of farmers' problems. There is insufficient evaluation and use of existing resources and farmer wisdom. There are shortages of agricultural supplies and inputs (e.g. crossbred animals, improved forage seeds, etc.).

Source: MPIDP FS

Internationally, it is normal practice to establish a central authority when developing a large irrigation scheme. This is done because there are so many sectors, factors and processes to monitor and manage both strategically and on a day-to-day basis that a single management organisation is essential if the scheme is to function effectively. The same point is made by the consultants responsible for the Feasibility Study of the Megech Pump (Robit) scheme (Halcrow-GIRD 2010), and (in relation to land acquisition, compensation and resettlement) for the MPIDP RAP (SMEC 2010). The MPIDP will not benefit from such a centralised organisation, and this is considered by the ESIA study team to be a potentially significant weakness in the project's organisational planning.

In practice, if no other solution is found, this function is likely to devolve onto the O&M contractor (the PSP contractor), which would be a significant expansion in scope and role. However, the ToR for the PSP contract (the Management Services Contract) already cover a number of important support and facilitation functions and allow for additional activities and services to be added to the contractor's activities if agreed with MoWE.

As a minor but important practical note: MoWE will provide the PSP contractor with permanent offices. It is assumed that these will be built by the construction contractor in the form of the "Administration Block" near the pumping station (see 2.5.1). This location is convenient for supervision of construction of the pumping station, main canal and Phase 1 components of the project (west of the Dirma River). However, for the long term, it would be far more efficient for the PSP contractor's offices to be located on the northern side of the command area, perhaps at Guramba, or at any rate with easy access to Kola Diba, the woreda headquarters. Such a location would greatly facilitate interaction with woreda staff, reduce the logistical issues relating to training, and facilitate interaction with project beneficiaries since the natural flows of goods and services are north-south to Kola Diba, not east-west to Gorgora.

Mitigation options:

- Review the project management structure to ensure that it includes clear mechanisms for effective planning, organisation and delivery of *all* the agricultural services and inputs needed for scheme success (over and above the three Action Plans developed in the NIRAS report), and task the appropriate office with development and implementation of a fully integrated and coordinated agricultural services and inputs programme.
- Review the planned location of the PSP contractor's permanent offices to maximise long-term efficiency and minimise average travel times.

Residual significance: this impact (risk) is fully mitigable, by establishing an effective, integrated project management organisation.

5.4.10.4 Inadequate Provision of Social Services and Infrastructure

Impact O39: the success and sustainability of the scheme depend on non-agricultural as well as agricultural interventions, particularly in domestic water supplies and health, and in road access. Failure to provide and maintain an appropriate level of investment in these areas would result in failure of the project to realise its potential.

Analysis: commercial smallholder irrigation schemes depend on non-agricultural as well as agricultural and financial services for their success, in particular improved provision of domestic water supplies and sanitation, health services, education, roads, electricity and telecommunications. The primary requirements are for easy access to safe domestic water supplies (to relieve women's excessive labour demands and with many other household-level benefits: see Impact O34), improved preventive and curative health services (see Impacts O30 to O33), and all-weather road access (see Impact O27). At present the quality and coverage of these services in and around the project area is low. They need to be improved but are dependent on government budgets. The project will construct and maintain some roads but does not include firm plans for any other social intervention.

The woreda administration is unable to focus its scarce resources on a specific project area - available funds are spent according to district-wide priorities; concentrating investment in the project area would divert government funds from other needy areas and increase inequality. Therefore it is important that additional funding for investment in the services essential for project success is found and that this is implemented as an integrated element of the project. Delivery mechanisms could include government departments, the PSP contractor, and NGOs such as ORDA. The ToR for the Management Services Contract already require the PSP contractor to "… *develop and implement activities specifically targeting the women, aiming at reducing their workload, improve female literacy and social status, and generate household income*"; this could be extended to cover other aspects of the necessary social investment. Note that a central executive office is recommended to ensure effective programme planning and delivery (see Impact O38).

Mitigation options:

- Develop, fund and implement a comprehensive plan for provision of *all* the non-agricultural services necessary for sustainable agriculture-based socio-economic development of the command area, as an integral component of the project (recommendations for implementation of social interventions are made in the ESMP).

Residual significance: this impact is fully mitigable, by establishing and implementing comprehensive non-agricultural community development initiatives in parallel with construction and commissioning of the project.

5.4.11 Economics

5.4.11.1 Inadequate Markets

Impact O40: if markets cannot be found for all the project's increased volume and range of produce, prices will fall and this will affect the scheme's economics.

Analysis: marketing is a key issue in relation to the success of the project. Marketing is not discussed in the FS in any detail, but instead is dealt with at length in two reports, a *Market Assessment Study* (the "ORGUT" report: Langmead *et al.* 2007) and the *Operational Action Plan for Commercial Production of Pulses and Oilseeds* (the "NIRAS" report: NIRAS 2009). As stated in the Market Assessment Study "*The thin domestic markets are a serious threat to the projects, even in the presence of a market and value-chain development component in the project … increasing production for local markets will drive farmers out of supply as prices fall.* ***This is by far the most challenging part of the project and should not be underestimated***" (emphasis added by ESIA report editor).

The NIRAS study responds by identifying rice as the probable future dominant crop and detailing three Action Plans, one for urgent farm-based trials to define the crop and other extension packages which will be required for promotion and distribution in the first year of scheme operation, one intended to ensure that a significant proportion of the project area is used for growing improved seeds for commercial sale, and one for the production and marketing of black cumin oleoresin. The study also outlines Action Plans related to (i) adding value to *noug* for both local and international markets, and (ii) accelerating the use of the Ethiopian Commodity Exchange (ECX) for trading in pulses and oilseeds.

Marketing outlets for both the Megech and Ribb schemes are illustrated spatially in Figure 5-3 below.

Mitigation options:

- Continue to develop and implement action plans for adding value and for market development, including access to market price information from the Ethiopian Commodity Exchange (ECX) using modern media (SMS, digital displays in market places, etc.).

Residual significance: nil adverse, if production and markets are linked successfully.

Figure 5-3: ENIDP Potential Production Outlets

Source: Consultant

5.4.11.2 Unaffordable O&M Costs

Impact O41: economic analysis of the scheme at feasibility level indicates that (i) recovery of the capital investment in irrigation infrastructure will not be affordable by farmers at household level, and (ii) farmers will be able to pay the full costs of off-farm O&M after full yield development of the proposed crop baskets.

Analysis: The MPIDP FS presents an approximation of a future farm household budget and concludes that after subtracting all expenses from the family revenues, *"… including the calculated costs of the planned on-farm irrigation system (both the capital and running cost components of O&M and energy), the family will be left with an annual residual of some Birr 5,500*." This is then converted to a figure of ETB 0.815 potentially available to pay for each m^3 of irrigation water supplied to the farm (water charge or water user's fee). Since the average on-farm water unit cost has been calculated to be 0.458 ETB/m^3, farmers are considered able to afford the full cost of surface irrigation O&M.

The calculations are based on a land holding of 1.07 ha, the existing average size, and therefore do not allow for the smaller household income which will be obtained from the future adjusted holdings of about 1.0 ha. However, this should make little difference in practice. Assuming that the proposed crop baskets are representative and that prices and profits are realistic, the major variable in this estimate is household expenses, currently estimated at ETB 3,506 (MPIDP FS). An annual income ("residual") of ETB 5,500 after these expenses is highly significant (~USD 333). Although it is very little on a per capita basis when considering a typical family of five or six struggling to improve their living conditions over a whole year (~USD 55/person), this a large amount in the local economy. However, it depends on successful operation of the scheme, uptake of the new farming systems by the beneficiaries, and favourable market conditions.

Mitigation options:

- Write off the scheme's capital costs.
- Phase-in O&M fees gradually, in accordance with farmers' ability to pay.

Note: it is understood that both these measures have already been identified by project management and are being incorporated into plans and budgets.

Residual significance: nil adverse, subject to the assumptions on costs and expenses being correct.

5.4.11.3 Under-funding of Capital and Operating Costs

Impact O42: as yet, no firm budget has been identified by this study for provision of some of the measures identified in this and other reports as being necessary for effective and sustainable operation of the scheme. If these prerequisites are not fully funded, then the project risks under-performance.

Analysis: it is a World Bank requirement that the full costs of all essential social and environmental mitigation measures are included in project budgets. This is done to ensure that the measures will be fully funded.

(a) The capital costs of constructing the MPIDP's off-farm physical infrastructure (irrigation, drainage and most roads) are estimated in the FS, with details provided in the various BoQs in the FS Annexes. Construction of the scheme will involve other costs, in particular (i) the costs of compensation, resettlement and associated entitlements (caused by the project's permanent land requirement and the need to reallocate land to be irrigated), (ii) the costs of field-level channel construction and land levelling, and (iii) the environmental and social mitigation measures required during pre-construction and construction, as identified in this report.

The costs related to land acquisition have been analysed by the RAP consultant and will be paid by the government, subject to approval of the RAP by the Bank (these amount to an estimated ETB 14,150,000 or ~USD 860,000: SMEC 2010). This total includes 10% for administration and implementation, including operation of the RAP-recommended Project Implementation Unit (PIU). This total may also cover the costs of the associated land consolidation and redistribution process, but this is not clear. The amount allowed for support for vulnerable groups (ETB 269,500 or ~USD 16,333) appears extremely low, equivalent to USD 40 per vulnerable household.

The on-farm costs of land levelling and channel construction are understood to be a beneficiary contribution (i.e. the farmers are expected to do this work without pay). This is unlikely to result in rapid uptake or adequate standards.

Estimated costs for the environmental and social mitigation measures are given in Chapter 8 (ESMP) of this report.

(b) The costs of operating the MPIDP's off-farm irrigation and drainage infrastructure are estimated in the FS. Operation of the scheme will involve many other costs if it is to function effectively, specifically (i) applied agricultural research, (ii) farmer training (including constructing and equipping training facilities (FTCs)), (iii) establishment and equipping of local centres for agricultural input supply (seeds, fertilisers, pest control products) and services (e.g. equipment hire, microfinance, marketing), (iv) construction of crop processing and storage facilities, (v) provision of significantly upgraded livestock husbandry advisory and health services, and (vi) the technical assistance and training needed to develop these organisations and systems to a sustainable level. Sustainable and efficient project operation will also require (vii) electrification of, at least, kebele headquarters, and a number of key social interventions, specifically (viii) safe domestic water supplies, (ix) an intensive adult literacy campaign, and (x) effective road maintenance. Further cost items will be the remaining environmental and social measures identified as essential to mitigate project impacts and meet project development objectives, including in particular (xi) health impact management and health status improvement, (xii) support for women's groups and microenterprises, and (xiii) enhanced fuelwood supply, amongst others. The final categories of costs will be biodiversity offsets and potential enhancement measures such as (xiv) fisheries management, (xv) lakeshore wetland restoration, and (xvi) a command area aquaculture trial.

It is understood that the costs of research (i) are being covered by ENIDP Component 2, together with some elements of extension and farmer training (ii); that ENIDP Component 3 will cover some aspects of the development of irrigation management capacity (iii); that the private sector is expected to be involved in service and supply provision (vi); and that Bank-sourced matching grants may be available to private sector investors involved in aspects of the scheme. This leaves unfunded - except by normal GoE budgets - many of the measures considered by this report and by others to be prerequisites for scheme success, especially social interventions including safe domestic water supplies, health care, and adult literacy. This poses a significant risk to project performance.

Mitigation options:

- Review the overall scheme concept and plan to ensure that funds are available for *all* project components required for scheme success.

Residual significance: highly positive if all measures are fully funded; potentially highly negative if funds for all necessary project components and measures are not provided.

6. Cumulative and Transboundary Effects

6.1 Introduction

This chapter discusses the project in relation to the many other water resource development projects planned for or already built in the Lake Tana basin.

No strategic ESIA on the Nile, the Blue Nile, or Lake Tana basins, taking into account the global programme of investment and water use in the future (hydropower, irrigation schemes, dams…), has been carried out yet.[97] Available impact reports are project-specific, dealing with individual investments and in general not taking into account interactions with other planned projects or cumulative effects. This chapter is a first attempt to address this gap for Lake Tana, focusing on quantitative aspects of water resources and their management. The analysis goes beyond the MPIDP scheme boundaries to Lake Tana, the Lake Tana basin, the Tana-Beles water system, the Abbay River basin within Ethiopia, and the overall Nile basin.

The Lake Tana basin covers an area of 15,083 km^2, at an average elevation of 2025 m asl. The mean annual outflow from the lake is about 4.3 km^3 under natural conditions. This is about 8% of the total flow of the Blue Nile, which contributes about 62% of the total flow of the Nile at the High Aswan Dam (McCartney *et al.* 2008).

Several large rivers (including the Megech, the Ribb, the Gumera and the Gilgel Abbay) and a large number of smaller streams feed Lake Tana, which covers about 20% of the basin area. During the rainy season large parts of the floodplains around the lake are inundated. Since 2001 the lake has been fully regulated by the Chara Chara weir.

On 14 May 2010 Lake Tana was connected to the Beles River basin by a tunnel to an upper tributary of the Beles River, on the occasion of the inauguration of the Beles Hydropower Plant. The primary purpose of this inter-basin transfer is power generation, but the transfer of water will also allow the development of irrigation downstream in the Beles basin.

To take account of this transfer, the water system analysed in this chapter is the "*Tana-Beles sub-basin of the Abbay River system*" (see the two Figure 6-1 and Figure 6-2 below), which includes the water demand of the Beles basin as well as the Lake Tana basin.

97 BRLi & T&A (2008).

Figure 6-1: Location of Irrigation Development Projects within Abbay Basin in Ethiopia

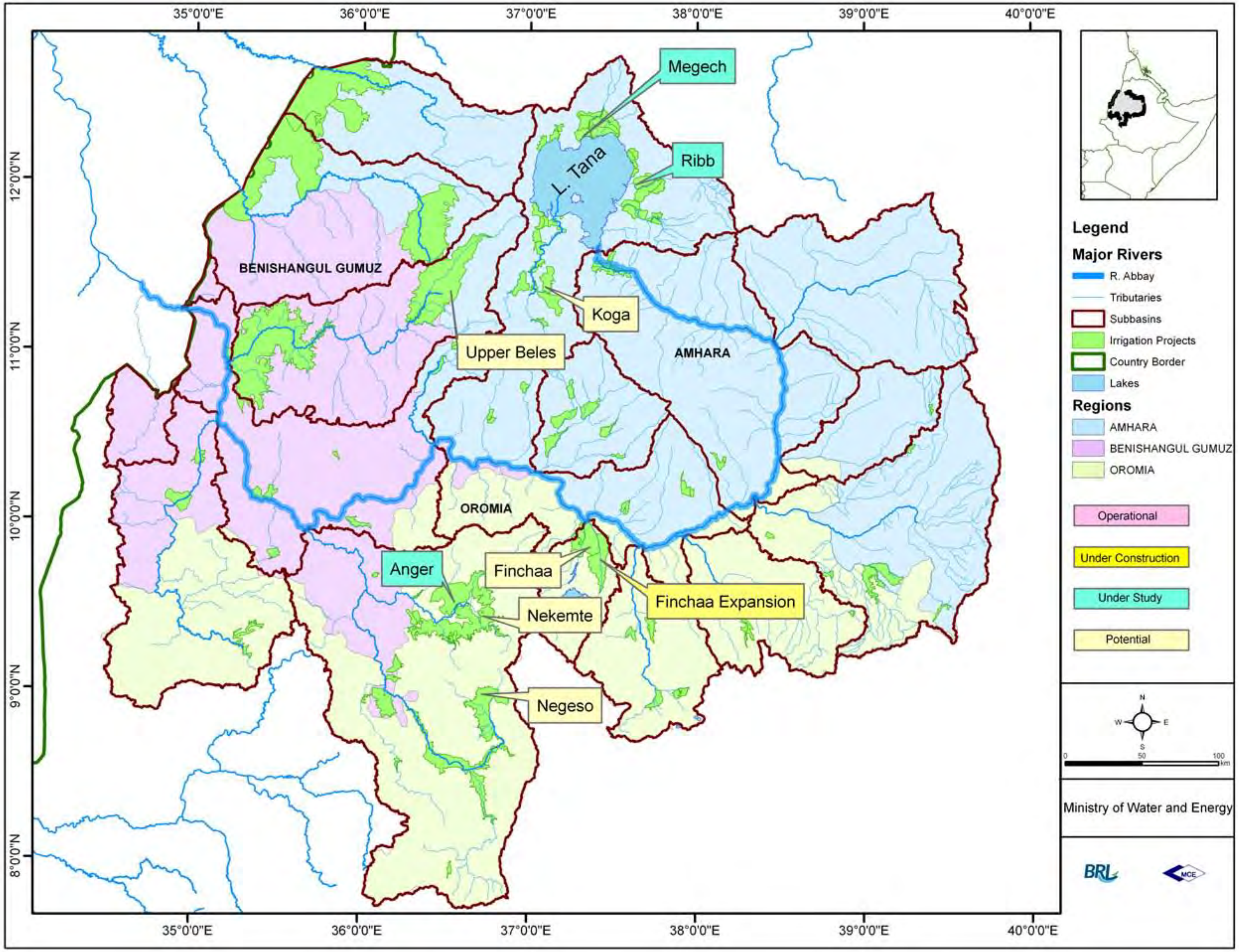


Figure 6-2: Location Map - Tana-Beles Sub-basins

6.2 WATER DEMAND

6.2.1 Main Water Regulation Structures and Projects

6.2.1.1 Chara Chara Weir

After many years of proposals, a weir at the outlet of Lake Tana was largely completed in 1996. Initially the weir had only two gates, each with a capacity of 70 m^3/s, and provided sufficient regulation only to improve power production from the Tis Abbay-I powerplant downstream. Five additional gates, also of capacity 70 m^3/s, were added to the weir in 2001, in association with the second power station (Tis Abbay-II, 72 MW). Since 2001 the weir has been operated by the Ethiopian Electric Power Corporation (EEPCO) (the successor to the EELPA) to maximise power production from both power stations, which until recently represented a significant proportion of Ethiopia's generating capacity (11% of the total grid-based capacity of the country (731 MW), 90% of which is generated by hydropower (World Bank, 2006)).

The Chara Chara weir regulates water storage in Lake Tana over a 3 m range from 1,784 m to 1,787 m asl. The active storage of the lake between these levels is about 9,100 Mm^3, which is approximately 2.3 times the average annual outflow.

Regulation for power production has modified the natural lake level regime, resulting in reduced seasonal but greater inter-annual variability.

The lowest water level ever recorded was in June 2003 when it dropped to 1,784.26 m. This was a drought year in much of Ethiopia and hydropower production was constrained in many places. To maintain electricity supplies production at Tis Abbay was maximised and as a result lake levels declined sharply. The consequences were significant: navigation ceased for approximately 4 months when the lake level dropped below 1,785 m, the minimum level at which ships can operate safely; there was significant encroachment of agriculture onto the exposed lake bed; large areas of papyrus were destroyed; and there was a decrease in fisheries production[98].

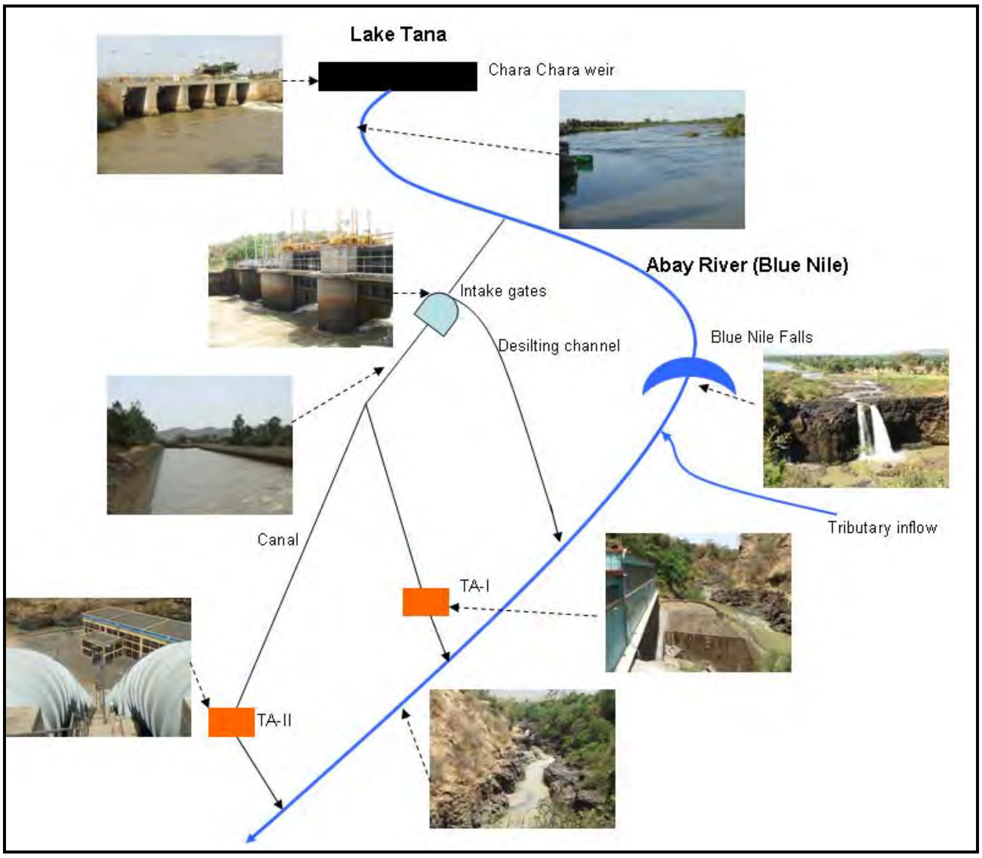
In 2010, following commissioning of the Tana-Beles hydropower scheme, the Tis Abbay-I and II power plants were to be shut down, and lake levels and outflows regulated to satisfy the demands of the tunnel transfer scheme. However, due to national power shortages, EEPCo has announced its intention to continue operation of the Tis-Abbay power plants[99].

Figure 6-4 below shows the mean monthly flow of the Tis Abbay, measured immediately downstream of the Chara Chara weir, for three periods:

- May 1959 to April 1996 (dashed line): this line illustrates the extreme seasonal variability in the natural flow regime, ranging from a mean of 346 m^3/s in September to just 12 m^3/s in June under unregulated conditions. On average only 12% of the natural discharge from the lake occurred in the 5 months February to June.
- May 1996 to December 2000: both the wet season flows and the dry season flows were significantly higher than occurred in the previous period. The higher dry season flows were a consequence of partial flow regulation by the two-gate Chara Chara weir. The higher wet season flows were a consequence of above average rainfall in these years, particularly in 1998. Mean annual flow in 1998 (196.0 m^3/s; 6182 Mm^3) was the highest annual discharge measured in the whole 48 year record.
- January 2001 to December 2006: this line illustrates the much higher dry season flows and reduced wet season flows arising as a consequence of full flow regulation by the Chara Chara weir with 7 gates. There is much less variability in flow from the lake: after 2001, 43% of the discharge from the lake occurred in the 5 months February to June.

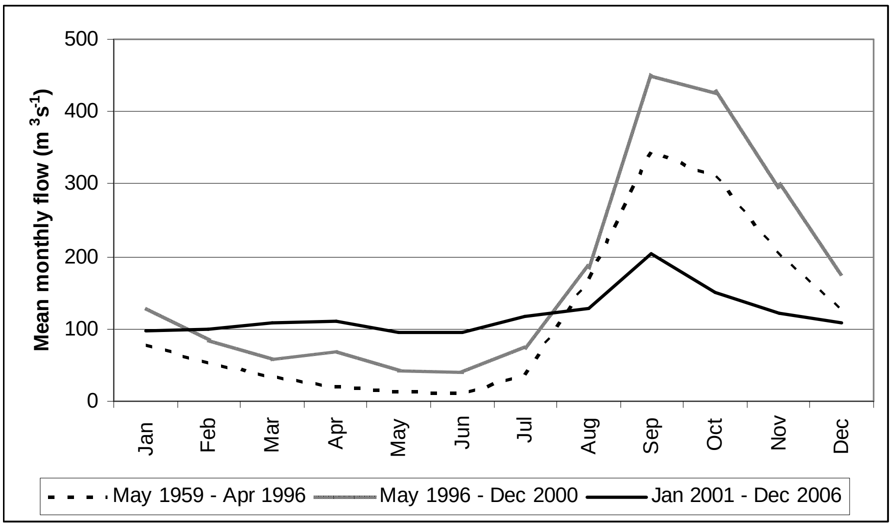
[98] EPLAUA, 2004. Water level reduction of Lake Tana and its environmental impacts. Bahir Dar. Ethiopia.
[99] Ethiopia-News, May 17, 2010.

Figure 6-3: Schematic of Abbay River (Blue Nile) downstream of Chara Chara Weir (not to scale)



Source: Gebre et al. (2008a).

Figure 6-4: Mean Monthly Flow from Lake Tana for Three Periods of Different Flow Regulation



	May 1959 - Apr 1996	May 1996 -Dec 2000	Jan 2001- Dec 2006
Jan	77.4	127.4	97.6
Feb	53.2	84.0	98.7
Mar	33.4	57.3	109.3
Apr	20.2	69.1	109.9
May	12.9	41.4	94.3
Jun	11.5	39.1	95.0
Jul	34.8	75.5	116.5
Aug	168.8	184.6	127.8
Sep	345.9	449.0	204.4
Oct	309.7	423.8	150.8
Nov	200.7	297.4	122.6
Dec	125.6	177.7	109.3
Mean	**116.3**	**169.0**	**119.7**

Source: McCartney et al. (2008).

6.2.1.2 Dams

Six dams and associated reservoirs have been built or are under construction or planned in the Lake Tana basin (Table 6-1).

Table 6-1: Major Dams in Lake Tana Basin

Name	Main Features	Status
Megech	76 m high storage dam on Megech River, 181 million m^3 reservoir	Design complete; construction pending financing
Ribb	73 m high storage dam on Ribb River, 233 million m^3 reservoir (see Photo 6-1)	Dam under construction; feasibility and detailed design studies for irrigation aspects ongoing, also ESIA of the irrigation and drainage aspects and a separate RAP
Gumera	33 m high storage dam on Gumera River, 223 million m^3 reservoir	Studied to design level; construction pending financing
Koga	25 m high storage dam on Koga River, 77 million m^3 reservoir	Dam complete, irrigation scheme under initial implementation
Jema	71 m high storage dam on Jema River, 173 million m^3 reservoir	Feasibility study complete
Gilgel-Abbay	Storage dam on Gilgel-Abbay River, 563 million m^3 reservoir	Feasibility study complete

Sources: MoWR website (accessed 31.12.2008), EEPCO website (accessed 05.01.2009) & project feasibility & other reports; note that the reports are inconsistent and all data is subject to verification

Together, the six dams will create a live storage volume of around 1,200 million m^3, which is about a quarter of the mean annual natural outflow from Lake Tana (4,300 million m^3).

Photo 6-1 : Ribb Dam under construction, January 2009.

Note : on the lower right side can be seen a diversion canal for the construction period.

6.2.1.3 Tana-Beles Transfer

The Tana-Beles hydropower project was inaugurated in May 2010. This scheme involves inter-basin transfer of water from Lake Tana to the Beles Basin through a 12 km long tunnel with an inner diameter of 7.1 m. The dual purpose of this inter-basin transfer is to use the large elevation difference between the lake and the (underground) powerhouse for the generation of hydropower, and to use the water downstream of the power plant for irrigation.

The operation rules of the tunnel transfer in the project's design documents are given as follows: no transfer if the lake level is too low (<1,784 m), 77 m^3/s in normal lake conditions, and 160 m^3/s if the lake level is too high (>1,787 m), with small variations according to the evolution of the lake level (increasing or decreasing) (operation rule adopted by Salini Costruttori & Studio Pietrangeli (2006)).

By design, after completion of the Tana-Beles hydropower project, some 65% to 70% of the natural outflow of Lake Tana will be diverted to the Beles Catchment.

6.2.2 Water Uses

6.2.2.1 Potable and Industrial Water Supply

The use of potable and industrial waters will increase in the growth-pole Lake Tana basin. In relation to water security, these uses are of great importance. However, the absolute volumes at stake are very small compared to current and future irrigation water requirements, and therefore can be neglected in the current quantitative analysis.

6.2.2.2 Irrigation

Areas

So far no large scale irrigation areas have been implemented in the Lake Tana sub-basin except for the Koga project, which is in its initial stages of commissioning. There are some small-scale irrigation schemes with a total area of a few hundred ha.

Apart from these small schemes and some traditional irrigation, flood recession agriculture is common around the lake when floodwaters recede and the lake level drops. The total area of recession cropping is estimated at some 25,000 to 30,000 ha, based on the total area flooded. Crops grown increasingly include rice.

Many potential sites for medium to large-scale irrigation have been identified in the Tana and Beles Basins, totalling approximately 108,000 ha in the Tana Basin and 139,000 ha in the Beles Basin (Table 6-2).

MPIDP Water Requirement

The MPIDP's crop water requirement is presented in the project's FS in sufficient detail for planning crop baskets and water demands, engineering, and economics. The FS uses the Penman-Monteith method, with crop- and climate-dependent values determined for all crops during their specific growing periods.

The gross water requirement is the volume of water that needs to be abstracted from Lake Tana by the pumping station for a given scheme design and crop basket, an essential parameter for engineering design. Part of the abstracted water returns to the lake through seepage (groundwater) or by surface flow (surface drainage). The difference between the gross water requirement and the return flows is consumptive use - water which is lost to the system - and is termed the net water requirement. The net water requirement is important for hydrological analysis at basin scale.

Annual net water requirements for Option III are given in Table 6-3. Monthly distributions of water demand have been generated by the ESIA Consultant and are presented in Figure 6-5 (these are not available in the FS).

It is interesting to notice that the unit net annual abstraction (8,136m^3/ha) is not far from the value assumed by the ENTRO-ENIDS Cooperative Regional Assessment (8,000 m^3/ha) and that used by SMEC for the Tana-Beles hydrological model (8,500 m^3/ha/year). The differences can be attributed to different assumptions concerning scheme efficiencies, irrigation methods (surface or pressure), and the fact that the SMEC model does not consider wet season supplementary irrigation.

For this ESIA study, the SMEC model has been updated and the water requirements substituted by the net requirements as given in the Figure 6-5.

Table 6-2: Proposed Irrigation Projects in Tana and Beles Basins

Name	Location	Area (ha)
Megech Pump	Seraba	4 400
	Robit	5 495
	Guramba	5 644
	Jarjer	8 517
Megech Gravity	Kola Diba	2 576
	Jiwana	4 735
North West Tana	Bebeha Abo	2 388
	Gawrna	1 076
	Fentay	706
	Delgi	2 550
Gumera	Guramba	1 542
	Mene Guzer	1 380
	Aba Kiro	424
	Bebeks	2 376
	Jigna	4 199
	Hod Gebeya	3 855
North East Tana	Mitrha	1 632
	Gubay Mariam	1 768
	Kirnya	842
	Agid/Kab	1 233
Ribb	Ribb	14 460
Durbete	Durbete 1	0
	Durbete 2	0
	Durbete 3	2 000
Gilgel Abbay	Ambo Plain	0
	Amri Plain	2 950
	Gug And Insewi	3 984
	Kongera/Debl Plain	4 165
	Chimba	1 921
	Diyaleg	1 168
	Lijome Riste	364
	Dimbk Plain	1 386
Jemma	Jemma	7 786
Koga	Koga	5 100
South West Tana	Istumit	1 041
	Asinwara	1 876
	Kunzla	1 960
	Lijomi Gabriel	255

Name	Location	Area (ha)
Beles	Upper Beles	53 720
	Lower Beles	85 000
TOTAL		**138 720**

Green	Under construction
Orange	Feasibility studies completed
Yellow	Feasibility studies ongoing
Light orange	Identification

Sources: SMEC, 2008: Hydrological Study of the Tana-Beles Sub-Basins, MPIDP FS for Megech areas, RIDP FS for Ribb area

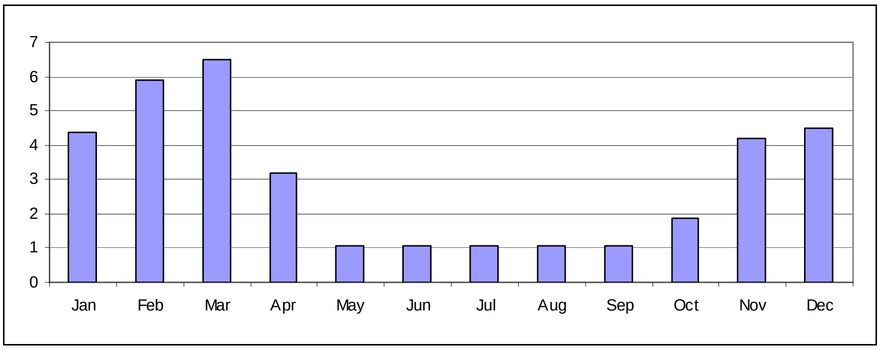
For the various scenarios, the net unit area abstraction of the other irrigation schemes in the Lake Tana basin are assumed to be equal to the MPIDP net abstractions. For the Beles basin, the net abstractions are taken from the SMEC model (the values are slightly lower).

Table 6-3: Total Annual Supplementary Water Requirement for MPIDP, Option III, gravity irrigation (million m^3)

Perennials	
Plantations	0.4
Grazing land	0.0
Subtotal perennials	*0.4*
Annuals	
Dry season supplementary	0.5
Wet season - supplementary	6.4
Dry season - surface irrigation	28.1
Dry season - pressurised irrigation	0.0
Subtotal annuals	*35.0*
Total	**35.4**
Total per ha	**8,856 m^3/ha**

Source: MPIDP, FS, Table C.1-11

Figure 6-5: Monthly Distribution of the Annual 35.4 Mm^3 Net Water Requirement (in Mm^3)



Source: Consultant for monthly distribution (after methods in SMEC model); MPIDP, FS, Table C.1-11 for annual demand.

6.2.2.3 Hydropower

The Ethiopian power sector is dominated by the state-owned Ethiopian Electric and Power Corporation (EEPCo), which controls electricity generation, transmission and distribution.

Salini Costruttori has completed a turnkey contract for the Tana-Beles Hydropower Project which transfers water from Lake Tana to the Beles Catchment through a 12 km long tunnel with an inner diameter of 7.1 m. The dual purpose objective of this inter-basin transfer is to use the elevation difference for the generation of hydropower (<460 MW) and to use the water for irrigation in the Beles area (123,000 ha).

The powerhouse contains 4 Francis turbines of 115 MW each for a total installed capacity of 460 MW. The net head is about 311 m and the rated discharge is 160 m^3/s. According to Salini Costruttori & Studio Pietrangeli (2006) the power plant will operate at a plant factor of 48%. This is why the operation rules of the tunnel transfer in the project design documents foresee a flow from Lake Tana of 77 m^3/s in normal lake conditions, and 160 m^3/s if the lake level is "too high". At present (May 2010) only one turbine is operating due to low water levels in the lake.

Table 6-4: Major Hydropower Projects in Lake Tana Sub-basin

Name	Main Features	Status
Tis Abbay I & II	11.4 MW and 73 MW hydroelectric projects using water diverted around the Tis Issat Falls	Operational since 1964 and 2001, respectively
Tana-Beles Hydropower Project	460 MW hydroelectric project diverting water from Lake Tana to the Upper Beles River; peaking operation	Inaugurated 14 May 2010; in theory will replace Tis Abbay I & II

Sources: MoWR website, EEPCO website & project feasibility & other reports; note that the reports are inconsistent and all data is subject to verification

A number of other hydropower projects are under study on the Abbay River and its tributaries (e.g. Karadobi, Mandaya, Beko-Ambo and Border).

6.2.2.4 Navigation

Lake Tana is the country's largest body of freshwater, has a significant population on its coasts and islands, and numerous important historical and tourist sites. Navigation is essential for the transport of people and goods, especially to the large population (~10,000) on the main island (Deke) and from the more isolated western part of the lake. The navigation authority lists eleven harbours around the lake.

Formal navigation is managed by the Lake Tana Transport Enterprise (LTTE), established in 1942 and based in Bahir Dar. The number of passengers carried by this service increased considerably after the Enterprise became autonomous in 2000. Revenue collected from transportation of the public, sand mining and sales and from other related services increased 31% between from 1994 to 2006 (Lake Tana Transport Enterprise data, 2006).

According to the Lake Tana Transport Enterprise, **the minimum level of the lake should be 1785 m asl to allow navigation**.[100] Below this level, navigation is restricted because of the many shallows and rocks in the lake. At a lake level of 1784.45 m asl many of the larger boats can hit rocks below the water surface, causing substantial damage. Major problems were experienced in June 2003 when the lake level dropped to an historic low of 1784.26 m asl (see Section 6.2.1.1 for explanation, also see footnote[101]). At this time, public transportation, sand mining, commercial navigation and tourism were disrupted and completely stopped for four months. Boats could also no longer reach the harbours along the western shore of the lake, and transport of goods and passengers between the ferries and the harbours had to done by shallow-draft barges. Access to markets, schools, and health facilities was seriously affected for thousands of people. According to the LTTE, very low lake levels occurred again in May to June 2009 forcing the cancellation of navigation by the larger vessels.

A minimum operation level of 1784 m asl, as proposed by Salini Costruttori & Studio Pietrangeli (2006) in connection with operation of the Tana-Beles transfer scheme, **is considered catastrophic for shipping** by the LTTE.

6.2.2.5 Tourism

Lake Tana is a major tourist feature on the "northern circuit", with a focus on the Tis Issat Falls (Photo 6-2), the islands and monasteries in the lake, and the relaxed ambience of Bahir Dar (the Falls are still being marketed as a major tourist attraction despite the drastically reduced flows since 2001).

Diversions to the original Tis Abbay-I power station had very little impact on flows over the Tis Issat Falls; between 1964 and 2000 average annual discharge over the falls is estimated to have been 128 m^3/s (i.e. 4,040 Mm^3). By comparison, after completion of the Tis Abbay-II, between 2001 and 2006 the average annual discharge over the falls is estimated to have been just 41 m^3/s (i.e. 1,305 Mm^3), with a minimum of just 4.7 m^3/s (i.e. 147 Mm^3) in 2004 and less than 12m^3/s (i.e. 378 Mm^3) in both 2003 and 2005. Between 2001 and 2006, in many months, the mean discharge was less than 50% what it was prior to 2001 (Figure 6-6).

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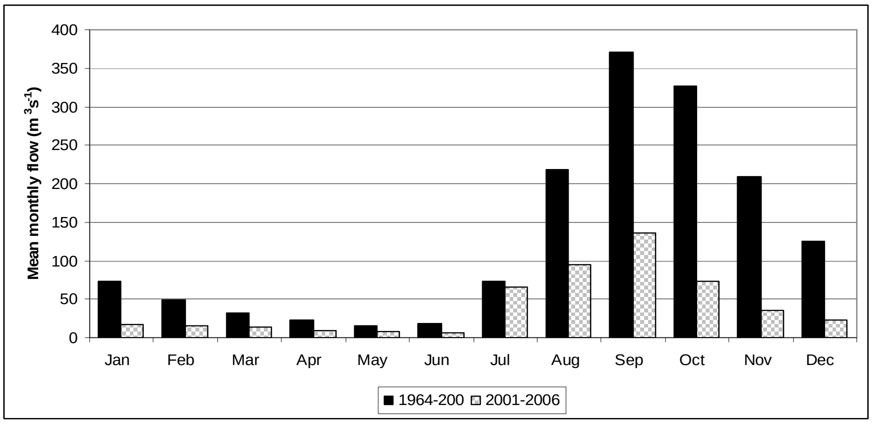
100 As stated in *SMEC, 2008: Hydrological Study of the Tana-Beles Sub-Basins*.

101 The low water level was a result of a dry year combined with inappropriate management of the new Chara Chara Weir. This low level is not seen in Figure 6-7 and Figure 6-11, since they are based on models which do not permit inappropriate weir management.

Figure 6-6: Comparison of Flows over Tis Issat Falls for 1964-2000 and 2001-2006



Source: McCartney et al. (2008).

As part of the Tis Abbay-II's EIA, an attempt was made to estimate flow requirements over the Tis Issat Falls. The focus was on tourist needs, so the evaluation was based primarily on the visual appearance of the falls. The largest flows were recommended for the peak tourist season from December to February, rather for the wet season when flows would naturally be highest, in order to make the falls appear most dramatic at this time (Table 6-5).

Table 6-5: Touristic Flows Recommended for Tis Issat Falls

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Flow (m^3/s)	60	60	10	10	10	10	20	20	40	40	40	60	
Volume (Mm^3)	161	146	27	26	27	26	54	54	104	107	104	161	995

Source: Howard et al. (1997).

Photo 6-2 : Tis-Issat Falls, January 2009

6.2.2.6 Environmental Flows

The following description is largely taken from McCartney *et al.* (2008). Environmental flows are the water that is left in a river, or released into it (e.g., from a reservoir), in order to maintain valued features of the ecosystem.

In recent years there has been a proliferation of methods for estimating environmental flows, ranging from relatively simple, low-confidence, desk-top approaches, to resource-intensive, high-confidence approaches. The more comprehensive methods are based on detailed multi-disciplinary studies, often involving expert discussions and collection of large amounts of geomorphological and ecological data. Typically they take many months, sometimes years, to complete.

A key constraint to the application of comprehensive methods, particularly in developing countries, is lack of data linking ecological conditions to specific flows. To compensate for this, several methods of estimating environmental flows have been developed that are based solely on hydrological indices derived from historical data. Although a myriad of factors influence the ecology of aquatic ecosystems (e.g., temperature, water quality and turbidity), the common supposition of these approaches is that the flow regime is the primary driving force.

One such method is the Desktop Reserve Model (DRM), which is intended to quantify environmental flow requirements in situations when a rapid appraisal is required and data availability is limited. The model is built on the concepts of the Building Block Method, which was developed by South African scientists over several years (King *et al.* 2000), and is widely recognised as a scientifically legitimate approach to setting environmental flow requirements.

The Building Block Method is underpinned by the premise that, under natural conditions, different flows play different roles in the ecological functioning of a river. Consequently, to ensure sustainability, it is necessary to retain key elements of natural flow variation. Hence, so called Building Blocks are different components of flow which, when combined, comprise a regime that facilitates the maintenance of the river in a pre-specified condition. The flow blocks comprise low flows, as well as high flows, required for channel maintenance and differ between "normal years" and "drought years". The flow needs in normal years are referred to as "maintenance requirements" and divided between high and low flow components. The flow needs in drought years are referred to as "drought requirements". The DRM provides estimates of these building blocks for each month of the year.

Recently, McCartney *et al.* (2008) have used the DRM to estimate environmental flow requirements in the Abbay River between the diversion to the Tis Abbay power stations and the point where the water is returned to the river. This reach includes the Tis Issat Falls. The requirements were based on a target Class C/D river reach, i.e. "modified" to "largely modified", with no adjustment for the aesthetic quality of flow over the Falls.

Table 6-6: Comparison of Environmental Flow Requirements computed by the DRM and Observed Mean Monthly Flows in the River Reach that includes the Falls, 2001-2006

Month	Flow over the Tis Issat Falls			
	Estimated maintenance requirement (Mm³/month)	Estimated drought requirement (Mm³/month)	Observed flows (Mm³/month)	Ratio of observed to "maintenance" (normal environmental flow) requirement
Jan	68	48	44	0.64
Feb	56	39	36	0.64
Mar	42	30	36	0.85
Apr	28	20	22	0.81
May	23	16	21	0.96
Jun	21	10	16	0.76
Jul	39	20	178	4.57
Aug	83	36	252	3.03
Sep	192	54	352	1.83
Oct	117	59	196	1.68
Nov	109	55	92	0.85
Dec	86	52	61	0.71
Annual	**862**	**440**	**1,305**	

Source: McCartney et al. (2008).

For the period 2001 to 2006, average annual flows over the falls (i.e., 1,305 Mm^3) exceeded the annual total maintenance flow requirements predicted by the model (i.e. 862 Mm^3, see Table 6-6). However, more detailed analysis shows that in most months average flows were significantly less than the environmental flow requirements predicted by the model. For several months average flows were less than 70% of the estimated requirement (see Table 6-6). Only in the months July to October (i.e. the wet season months) did the average flow over the period 2001 to 2006 exceed the recommendation of the DRM. **This suggests that, in recent years, dry season flows have been insufficient to maintain basic ecological functioning of this reach of the Abbay River.** Furthermore, even though the average annual flow over the period exceeded the DRM recommendation, in several years even the wet season flow was much less than recommended. For example, in September and October 2005, flows over the falls were estimated to have been just 44 Mm^3 and 7.6 Mm^3 respectively, less than even the recommended minimum drought period environmental flows.

In considering environmental flows, it is important to remember that there are many methods of estimating them. The flows chosen for management purposes are, inevitably, value judgements, based on balancing the needs of different users and different values. Once agreed, they should, by definition, be given a high priority (if not the highest priority) in water management. The flows presented in Table 6-6 above are the most recent and relevant estimation of environmental flow requirements at the outlet of Lake Tana, but as stated were not derived by a formal process of negotiation involving all water stakeholders.

6.3 LAKE TANA - WATER BALANCE SCENARIOS

6.3.1 Observed Outflows and Water Levels

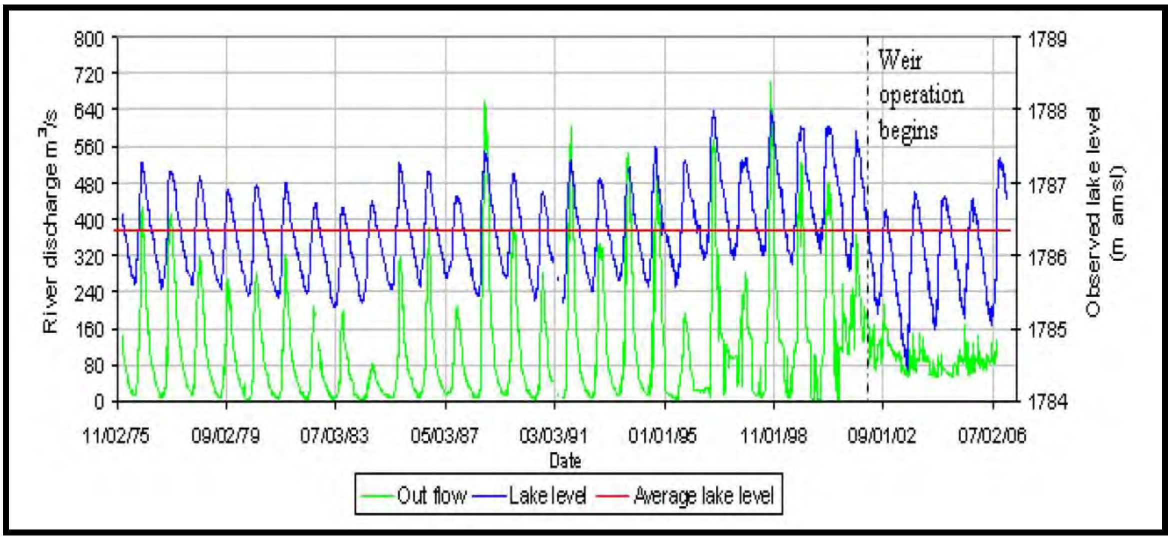
Construction of the Chara Chara weir and upstream water resources development have altered Lake Tana's natural water balance. Therefore, it is important to get a baseline picture of the lake behaviour, taking into account the main recent water resources development and being a control sample for the scenarios to come.

Outflows from Lake Tana and lake level data are available from 1959, with some missing flow data in 1982 and 1991; the lake level data at Bahir Dar station has partial missing data for 1991.

In 2001 a weir began operation at Chara Chara across the Abbay River at the outlet of the lake. The weir is equipped with two radial gates which allow the release from the lake to be totally controlled as long as the water level of the lake remains lower than the elevation of the spillway (1,787 m); the minimum operating level of the weir is 1,784 m. EEPCo does not collect continuous records of lake levels at the weir. Occasional measurements are made during visits.

As shown in Figure 6-7, observed lake levels vary by some 1.6 m annually. Since the operation of the weir lake levels have dropped, reaching a historical minimum water level of 1784.46 m on 30 June 2003. The outflow data (river flow recorded 5 km below the weir) show that after weir operation started the natural flow of the river was altered.

Figure 6-7: Observed Outflows and Lake Levels, Lake Tana, 1975-2006



Source: Wale (2008).

6.3.2 Scenario 0: Baseline

6.3.2.1 Water Allocation Model

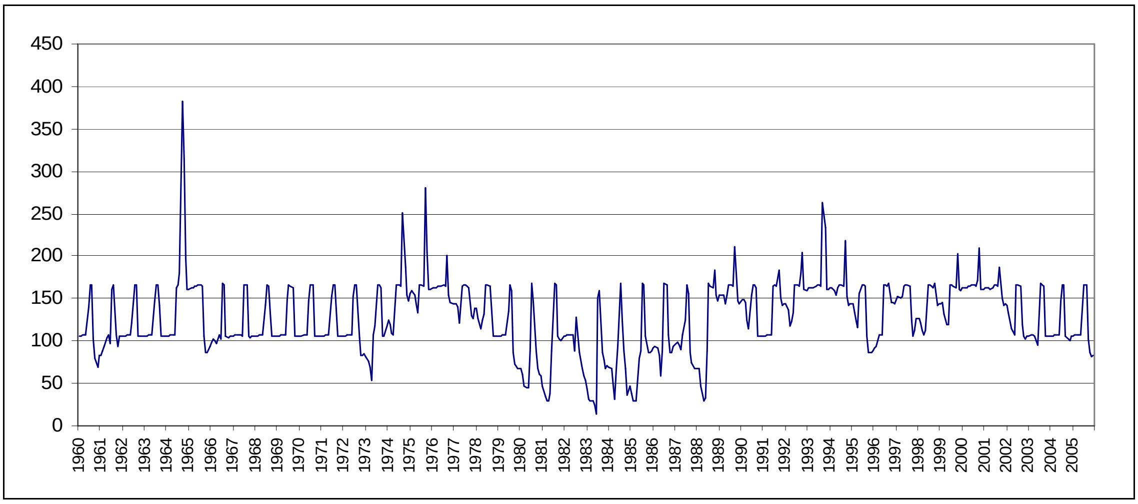
To predict the lake's future behaviour the ESIA Consultant used the Water Allocation Model developed by SMEC (2008a, 2008b).

The baseline scenario consists of application of the observed hydrology of the years 1960 to 2006 to the current water resources development picture, i.e. with 2009 infrastructure and operations (this corresponds to SMEC scenario S0A). For example, the Baseline Scenario allows one to see the impacts of the Chara Chara weir on hydrological conditions corresponding to 47 past recent years. This is why the outflows of Figure 6-8 below are closer to the recent flows of Figure 6-7 above rather than to the observed flows before the construction of the weir.

6.3.2.2 Baseline Scenario, Lake Outflows and Levels

Simulated monthly outflows from Lake Tana are graphed in Figure 6-8.

Figure 6-8: Lake Tana Monthly Outflows (m^3/s) in the Baseline Scenario, 1960-2006



The complex patterns of water inputs and losses can cause large daily and seasonal water level fluctuations in the lake. Water levels are highest at the end of the main rainy season and during the post rainy period, slowly decreasing to a minimum around the end of the dry season (see the Figure 6-9, Figure 6-10 and Figure 6-11 below). The mean difference between the minimum monthly water level (in May-June) and the maximum monthly water level (in September-October) is 1.54 m in the baseline scenario (with a low standard deviation: 0.26 m). Larger differences should be apparent if one looks at the daily levels.

Figure 6-9: Lake Tana Monthly Level (m) in Baseline Scenario (no regulation or abstraction upstream), 1960-2006

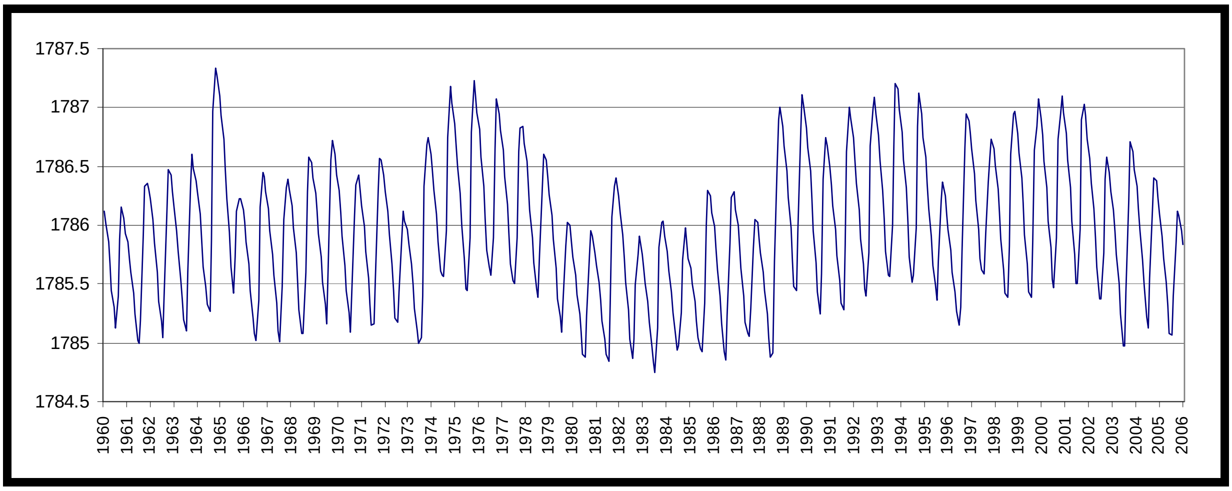


Figure 6-10: Lake Tana Mean Monthly Level (m), Baseline Scenario, 1960-2006

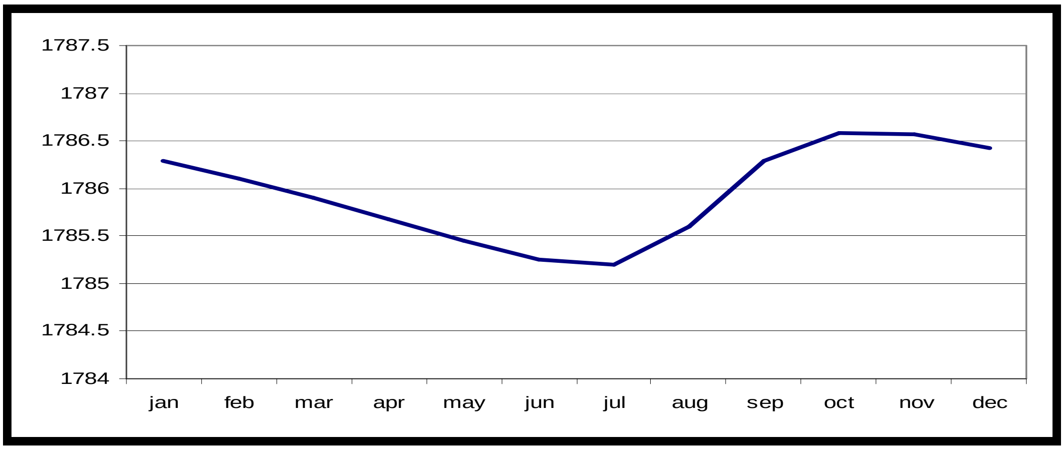
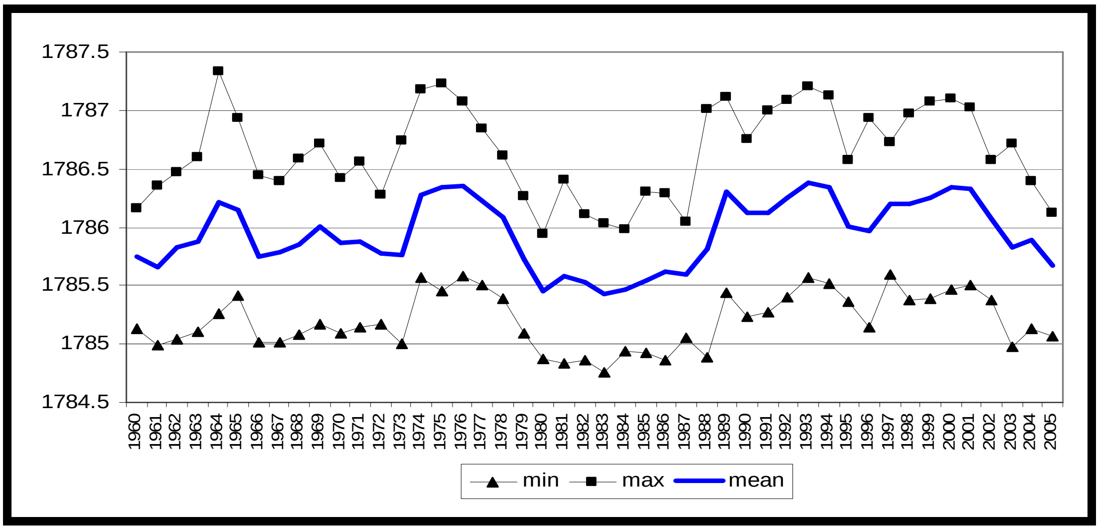


Figure 6-11: Lake Tana Mean, Maximum and Minimum Annual Levels (m), Baseline Scenario, 1960-2006



6.3.2.3 Baseline Scenario, Lake Tana Water Balance, Mean Year

The total annual inflow of water to the Lake is $9.1*10^9$ m^3/year (54% runoff and 46% direct rainfall). The outflow of the Blue Nile River is 44% of this, i.e. $4.0*10^9$ m^3/year. The large difference between inflow and outflow is caused by the high evaporation losses ($5.1*10^9$ m^3/year). As seen in the Figure 6-12 below, from October to June evaporation exceeds input via rainfall and during this time many of the inflowing streams dry up completely. Table 6-7 below sums the columns in Figure 6-12 and shows a global equilibrium of the lake water balance because the level at the end of the baseline period is almost the same as the starting level.

Figure 6-12: Lake Tana Average Monthly Water Balance (Mm^3) in the Baseline Scenario, 1960-2006

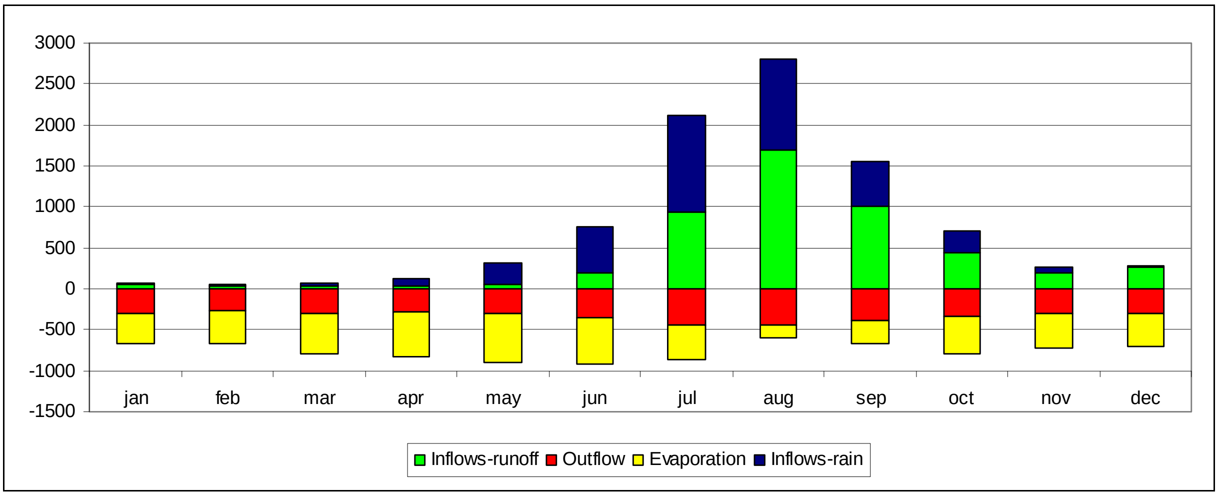


Table 6-7: Lake Tana Average Water Balance (Mm^3) in Baseline Scenario, 1960-2006

(10^6 m^3)	Inflow: runoff	Inflow: rain	Evaporation	Outflow	Balance
Oct -> Jun	1,280	1,356	-4,263	-2,740	-4,367
Jul -> Sep	3,638	2,850	-872	-1,260	4,356
Total	**4,918**	**4,206**	**-5,135**	**-4,000**	**-11**

6.3.2.4 Baseline Scenario, Lake Tana Water Balance, Dry Year

It is of special interest to examine the lake water balance during dry years. There are many ways to select the dry years to be studied. Figure 6-13 below illustrates the lake's water balance during the nine 5-year return period years with little inflow (runoff + rain): 1965, 1972, 1979, 1980, 1982, 1983, 1984, 1987, and 1985. Because of climatic cycles, dry years tend to be grouped; for this reason, the behaviour of the lake during the almost consecutive dry years between 1979 and 1984 is of special interest. The impacts of this drought period are clearly visible on Figure 6-8, Figure 6-9, and Figure 6-11 above. Table 6-8 shows that during dry years the lake is no longer in equilibrium; the balance is negative, with consequences for lake water levels.

In dry years the model indicates that:

- precipitation decreases by 15% in both the dry and wet seasons;
- inflows to the lake from runoff decrease by 27% in both the dry and wet seasons;
- lake outflows therefore decrease by 20% overall (23% in the dry season and 15% in the wet season).

Note: there is no change in evaporation because the model only uses mean monthly evaporation parameters (in mm). In reality, the evaporation faces two opposing phenomena: evaporation increases due to higher temperatures and increased sunshine, but the lake surface area decreases.

Figure 6-13: Lake Tana Monthly Water Balance (Mm^3) in the Baseline Scenario, Dry Years

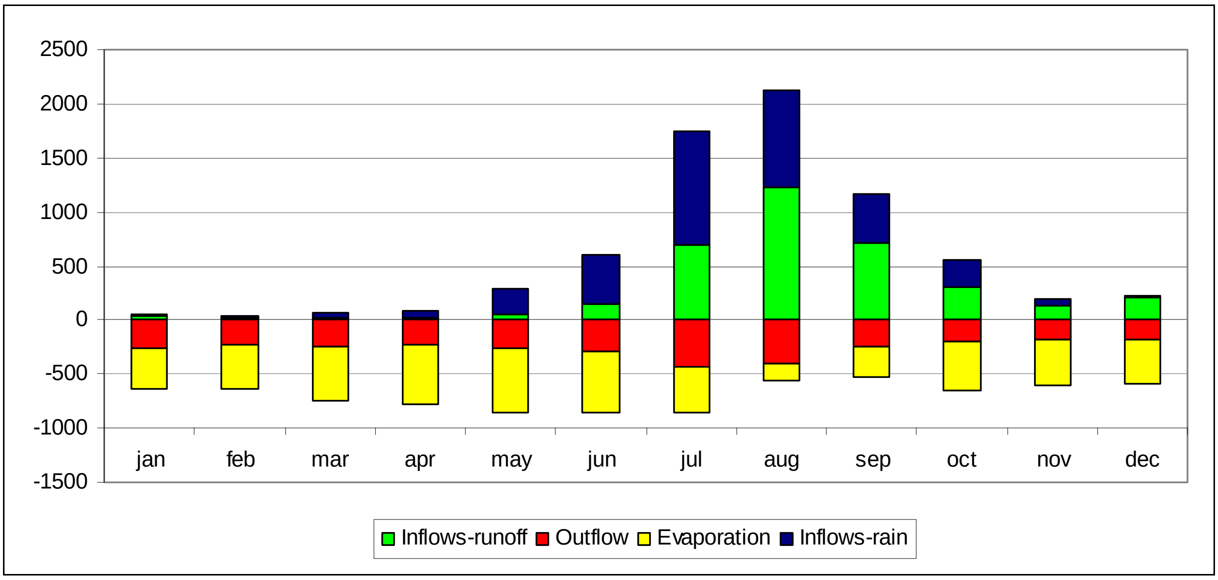


Table 6-8: Lake Tana Average Water Balance (Mm^3) in Baseline Scenario, Dry Years

(10^6 m^3)	Inflow: runoff	Inflow: rain	Evaporation	Outflow	Balance
Oct -> Jun	958	1,153	-4,246	-2,108	-4,242
Jul -> Sep	2,643	2,402	-866	-1,073	3,107
Total	**3,602**	**3,556**	**-5,112**	**-3,181**	**-1,136**

6.3.3 Scenario 1: Implementation of MPIDP

In this scenario, the MPIDP net monthly water abstractions (see Figure 6-5 above) are added to the model, which is re-run for the same period, 1960-2006.

The 35.4 Mm^3 net water abstraction required by MPIDP (consumptive use) has only a small impact on the behaviour of the lake since the mean annual inflow into the lake is 4,918 Mm^3.

The minimum monthly Lake Tana level decreases by 8 mm from 1,784.752 in the baseline scenario to 1,784.744 m; this is insignificant.

The difference between the minimum monthly water level (in May-June) and the maximum monthly water level (in September-October) increases from 1.45 m in the baseline scenario to 1.49 m.

The following two tables show the Lake Tana water balance in a mean year and in a dry year. Comparison with the equivalent tables for the baseline scenario shows that (i) the MPIDP abstractions reduce the overall lake outflow (by a very small amount), and (ii) that the other volumes under consideration (evaporation from the lake, precipitation over the lake, global lake water balance) are not affected by the relatively small abstraction for the MPIDP.

Table 6-9: Lake Tana Average Water Balance (Mm^3), Scenario 1 (with MPIDP), 1960-2006

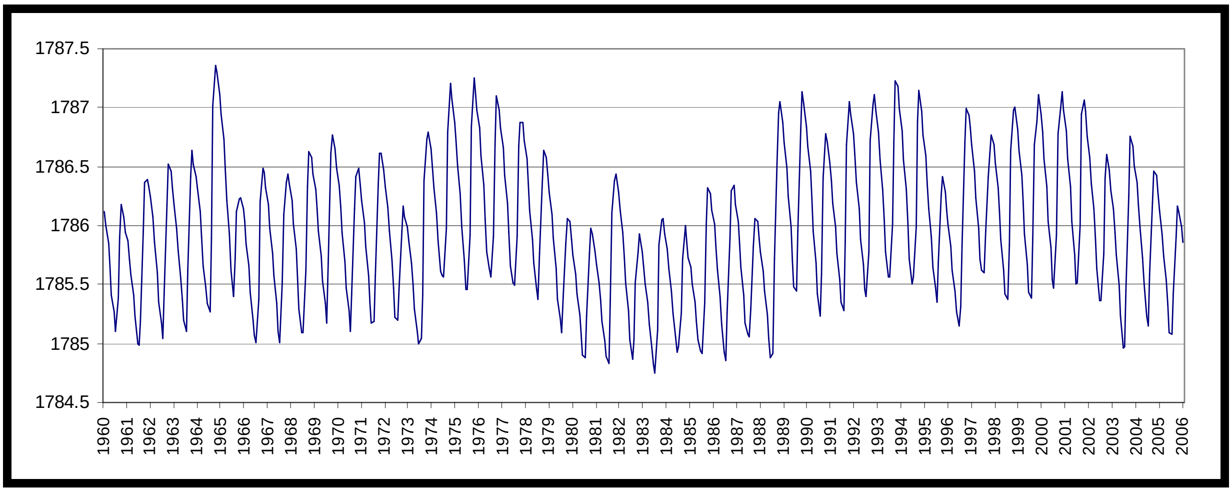
(10^6 m^3)	Inflow: runoff	Inflows: rain	Evaporation	Outflow	Abstractions	Balance
Oct -> Jun	1,280	1,356	-4,262	-2,712	-33	-4,371
Jul -> Sep	3,638	2,850	-872	-1,254	-3	4,359
Total	**4,918**	**4,205**	**-5,134**	**-3,965**	**-36**	**-12**

Table 6-10: Lake Tana Average Water Balance (Mm^3), Scenario 1 (with MPIDP), Dry Years

(10^6 m^3)	Inflow: runoff	Inflows: rain	Evaporation	Outflow	Abstractions	Balance
Oct -> Jun	958	1,153	-4,245	-2,077	-33	-4,243
Jul -> Sep	2,643	2,402	-866	-1,067	-3	3,109
Total	**3,602**	**3,555**	**-5,111**	**-3,144**	**-36**	**-1,134**

The fact that MPIDP only has a small effect on Lake Tana's water balance can be seen in Figure 6-14, which is similar to Figure 6-9 in the baseline scenario.

Figure 6-14: Lake Tana Monthly Levels (m) in Scenario 1 (with MPIDP), 1960-2006



6.3.4 Scenario 2: Medium Irrigation Development

This scenario is based on the previous scenario (baseline + MPIDP), with the following additional irrigation users:

- Megech gravity (7,311 ha), linked to the Megech Dam;
- Gumera (13,876 ha), linked to the Gumera Dam;
- Ribb (14,460 ha), linked to the Ribb Dam;
- Gilgel Abbay (15,938 ha), linked to the Gilgel Abbay Dam;
- Koga (5,100 ha), linked to the Koga Dam.

These irrigation projects have already passed the identification stage, and one, the Koga project has started operating. They are all limited to the Lake Tana basin (the Beles transfer is considered in the next scenario).

For the purpose of this scenario, the water requirements per irrigated ha are taken to be the same as for the Megech irrigation project (8,136 m^3/ha/year, see Figure 6-5 for the monthly breakdown). The purpose of this scenario is to give an estimation of the possible irrigation schemes' combined impacts on Lake Tana's water balance. The irrigation projects' characteristics are the ones used by SMEC for their scenarios S3 and S4 (SMEC 2008).

The following tables, similar to the ones shown in the previous scenarios, show that medium irrigation development will have a significant impact on the Lake Tana water balance. Indeed, compared to the scenario with MPIDP alone, the mean annual outflow decreases by 11% and the dry-year annual outflow by 15% (if one only considers the months from October to June, this last value increases to 17%). The mean annual inflows to Lake Tana decrease by 469 Mm^3, which is mainly (98%) due to upstream abstractions for the new irrigation developments, the remainder being due to losses from the new reservoirs (evaporation and seepage).

The minimum monthly water level in the lake decreases by 10 cm, from 1,784.75 in the baseline scenario to 1,784.65 m asl. This is a very small reduction. The lake does not reach its dead storage level (1,784.00 m asl). The mean monthly level decreases from 1,785.96 in the baseline scenario to 1,785.82 m asl (a reduction of 15 cm). The mean area of the lake decreases by 8 km^2, from 3,067 to 3,059 km².

Table 6-11: Lake Tana Average Water Balance (Mm^3), Scenario 2 (Medium Irrigation Development), 1960-2006

(10^6 m^3)	Inflow: runoff	Inflow: rain	Evaporation	Outflow	Abstractions from Lake Tana	Balance
Oct -> Jun	1,105	1,353	-4,251	-2,338	-33	-4,164
Jul -> Sep	3,345	2,843	-870	-1,174	-3	4,141
Total	**4,449**	**4,195**	**-5,120**	**-3,511**	**-36**	**-23**

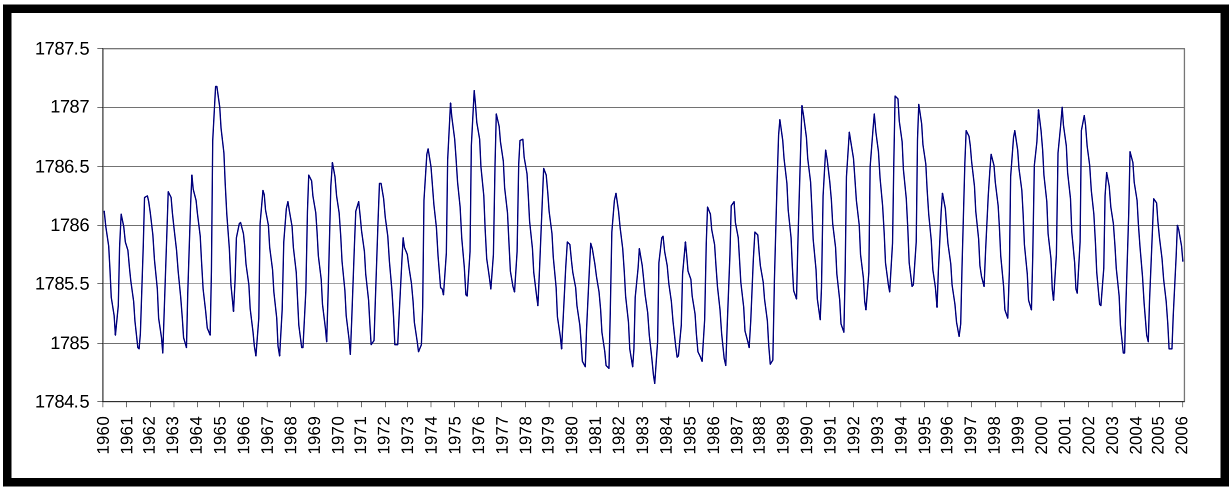
Table 6-12: Lake Tana Average Water Balance (Mm^3), Scenario 2 (Medium Irrigation Development), Dry Years

(10^3 m^3)	**Inflow: runoff**	**Inflow: rain**	**Evaporation**	**Outflow**	**Abstractions from Lake Tana**	**Balance**
Oct -> Jun	812	1,151	-4,235	-1,730	-33	-4,035
Jul -> Sep	2,324	2,397	-864	-948	-3	2,905
Total	**3,137**	**3,548**	**-5,100**	**-2,679**	**-36**	**-1,130**

The mean outflows decreases by 450 Mm^3, from 3,965 Mm^3/year in the previous scenario (MPIDP alone) to 3,511 Mm^3/year. This decrease logically corresponds to the additional net abstractions in the Lake Tana basin.

Figure 6-15 shows that the assumed minimum operating level of Chara Chara Weir (1784.75 m asl) is often reached during the modelled sequence of dry years.

Figure 6-15: Lake Tana Monthly Levels (m) in Scenario 2 (Medium Irrigation Development), 1960-2006



6.3.5 Scenario 3: Tana-Beles Water Transfer

This scenario is based on Scenario 2 (above), plus the Tana-Beles water transfer. The transfer is based on the following three water demand factors:

- Hydropower: target water demand of 100 m^3/s for Tana-Beles.
- Hydropower: no more lake water demand for the Tis Abbay power plants.
- Irrigation: 53,720 irrigated ha in the Upper Beles catchment (Note: the annual net water requirement per ha is only 83% of the MPIDP demand due to the higher water use efficiency estimated by SMEC (2008)).

In this scenario the outflows from Lake Tana are mainly oriented towards the Beles catchment, as shown in Table 6-13,

Table 6-14 and

Figure 6-16.

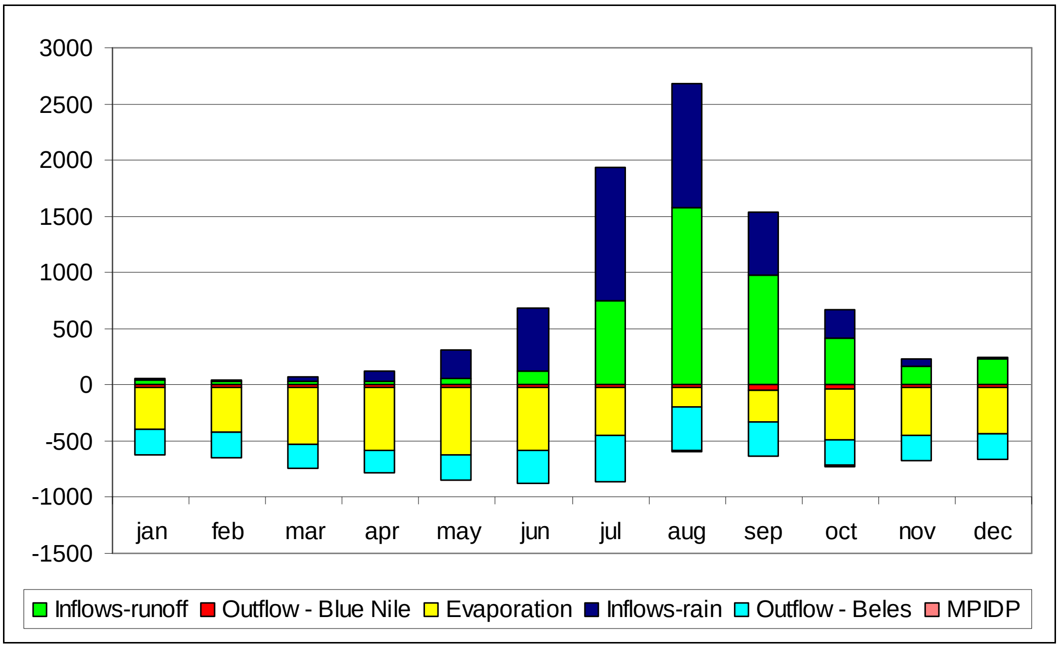
Table 6-13: Lake Tana Average Water Balance (Mm^3), Scenario 3 (Tana-Beles Transfer), 1960-2006

(10^6 m^6)	**Inflow: runoff**	**Inflow: rain**	**Evaporation**	**Outflow Blue Nile**	**Outflow Beles**	**Abstractions from Lake Tana**	**Balance**
Oct -> Jun	1,109	1,352	-4,247	-239	-2,067	-33	-4,125
Jul -> Sep	3,308	2,841	-869	-105	-1,106	-3	4,066
Total	**4,417**	**4,193**	**-5,116**	**-344**	**-3,173**	**-36**	**-59**

Table 6-14: Lake Tana Average Water Balance (Mm^3), Scenario 3, Dry Years

(10^6 m^3)	Inflow: runoff	Inflow: rain	Evaporation	Outflow Blue Nile	Outflow Beles	Abstractions from Lake Tana	Balance
Oct -> Jun	818	1,150	-4,232	-236	-1,401	-33	-3,935
Jul -> Sep	2,301	2,396	-864	-79	-872	-3	2,878
Total	**3,119**	**3,546**	**-5,096**	**-315**	**-2,273**	**-36**	**-1,056**

Figure 6-16: Lake Tana Average Monthly Water Balance (Mm^3), Scenario 3 (Tana-Beles Transfer), 1960-2006



The above tables, similar to the ones shown in the previous scenarios, show that **the Tana-Beles transfer will have a high impact on Lake Tana outflows to the Blue Nile**: these will be only 10% of what they were before (90% going to the Beles catchment), unless a minimum flow release (environmental flow) is implemented.

In this scenario, over the period modelled (1960-2006) the minimum monthly level of the lake remains around 1,784.6 m because the minimum operating level of the Chara Chara Weir is fixed - in the model - at 1,784.75 m. The mean monthly lake level decreases by 20 cm, from 1,785.96 in the baseline scenario to 1,785.77 m. The mean area of the lake decreases by 11 km^2, from 3,067 to 3,056 km².

The critical level for navigation (1785 m asl) is reached in 24 of the 49 years (Figure 6-17), compared with only 9 in 49 years under the Baseline Scenario.

Figure 6-18 shows that in this scenario (Tana-Beles Water Transfer), the Upper Beles irrigation schemes face 9 years of deficit over the 47-year model period. The deficits therefore have a return period of about 5 years. The deficit years are grouped and similar to the dry years which may be observed in Figure 6-17, because (in the model) the Tana-Beles Transfer scheme reduces the amount of water it takes when the lake level is too low.

Raising the assumed minimum operating level of Chara Chara Weir (1784.75 masl in the various scenarios) would lead to a reduction in the occurrence of non-navigable months, but would increase non-satisfaction of the irrigation requirements and would reduce the Blue Nile outflows.

In conclusion, **under Scenario 3 it is impossible to satisfy all the users' water requirements, even for only 4 years out of 5**.

Figure 6-17: Lake Tana Monthly Levels (m) in Scenario 3 (Tana-Beles Transfer), 1960-2006

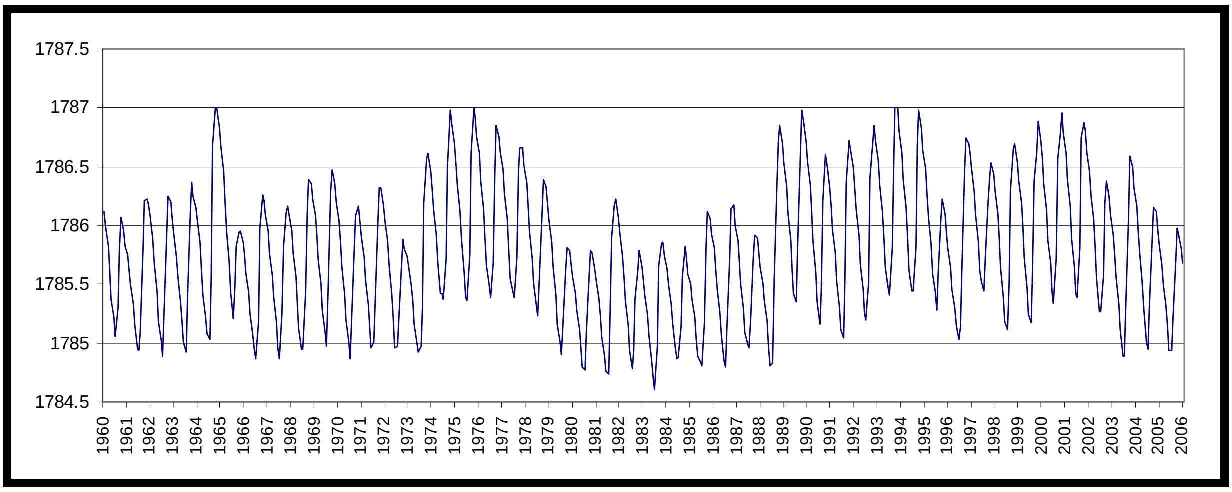
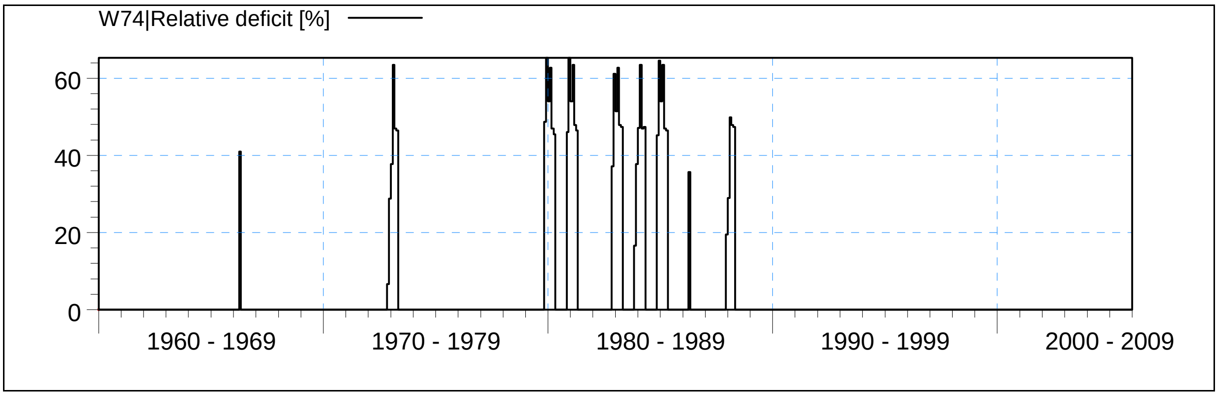


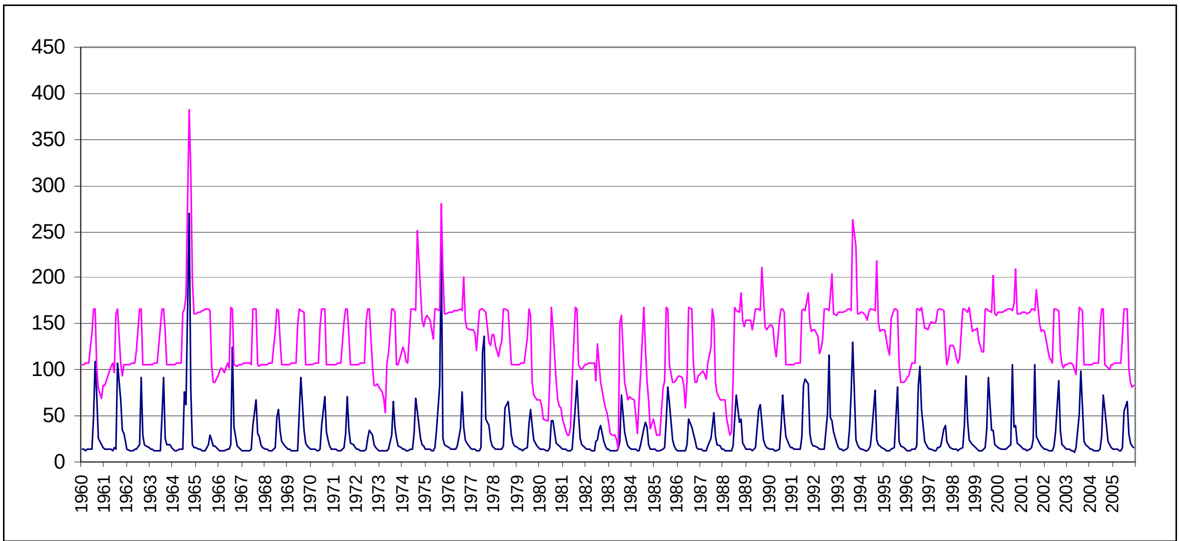
Figure 6-18: Irrigation deficit for the Upper Beles irrigation scheme under Scenario 3 (Tana-Beles Transfer), 1960-2006



The following Figure 6-19 shows the flows at the outlet of the lake under both the baseline and full development scenarios. It clearly illustrates the highly significant reduction in water availability for the Tis Abbay and for the Tis Issat Falls as a result of diversions through the Tana-Beles tunnel.

Figure 6-19 also illustrates the need for the development and application of minimum flow release rules if any environmental flow requirements or the visual requirements for tourism are to be satisfied.

Figure 6-19: Tis Abbay Flows (m/s), Baseline Scenario (pink) and Scenario 3 (blue), 1960-2006



6.3.6 Scenario 4: Tana-Beles Water Transfer + Minimum Release Rules

This scenario examines what would happen if a minimum release was established for the Abbay River (Blue Nile) in addition to the abstraction required for the Tana-Beles Transfer scheme (Scenario 3).

The flow release rule used in Scenario 4 is the one presented in Table 6-5 (touristic flows recommended for Tis Issat Falls), which is less demanding than the environmental flow requirement presented in Table 6-6. These flows are added to those required under Scenario 3.

The following figures have a similar format to those presented above. They clearly show the conflicts between water users and the need to prioritise the uses of the Lake Tana Basin waters.

In these figures, Scenario 3 is shown in blue and prioritises minimum Lake Tana water levels, hydroelectricity and irrigation; in Scenario 4 (pink), downstream water release is prioritised.

Figure 6-20: Tis Abbay Flows (m/s), Scenario 4 (pink) and Scenario 3 (blue), 1960-2006

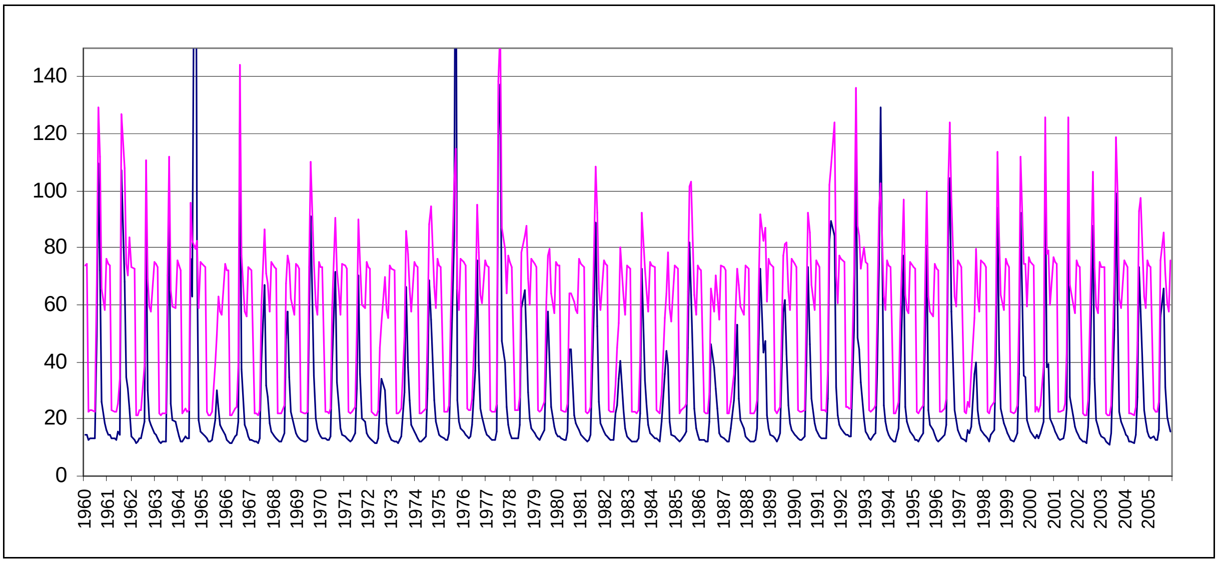


Figure 6-21: Irrigation Deficit for the Upper Beles irrigation scheme in Scenario 4 (pink) and Scenario 3 (blue), 1960-2006.

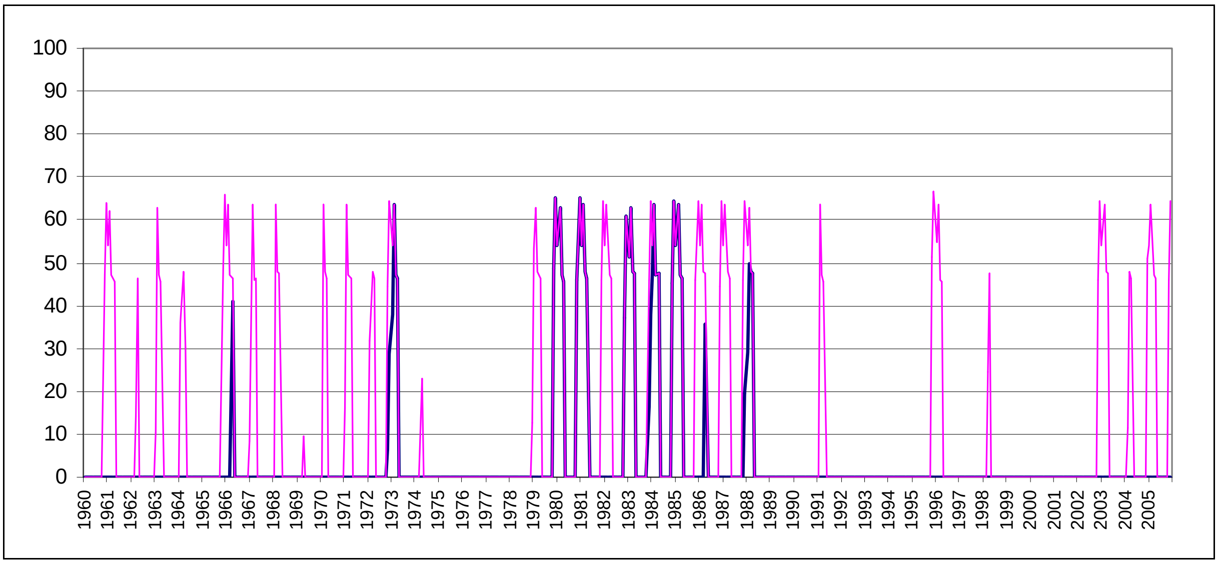


Figure 6-22: Lake Tana Monthly Level (m) in Scenario 4 (pink) and Scenario 3 (blue), 1960-2006

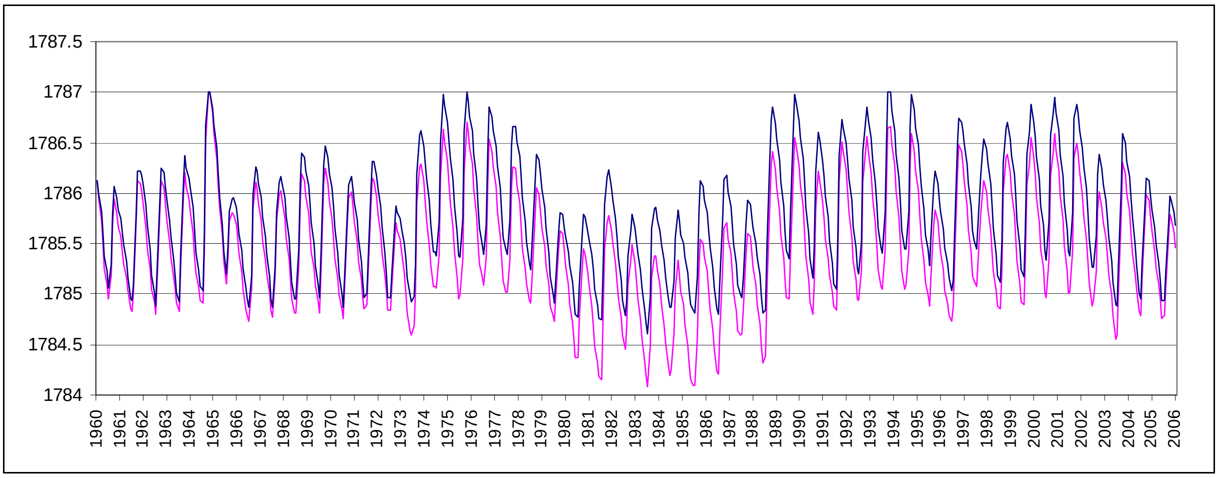
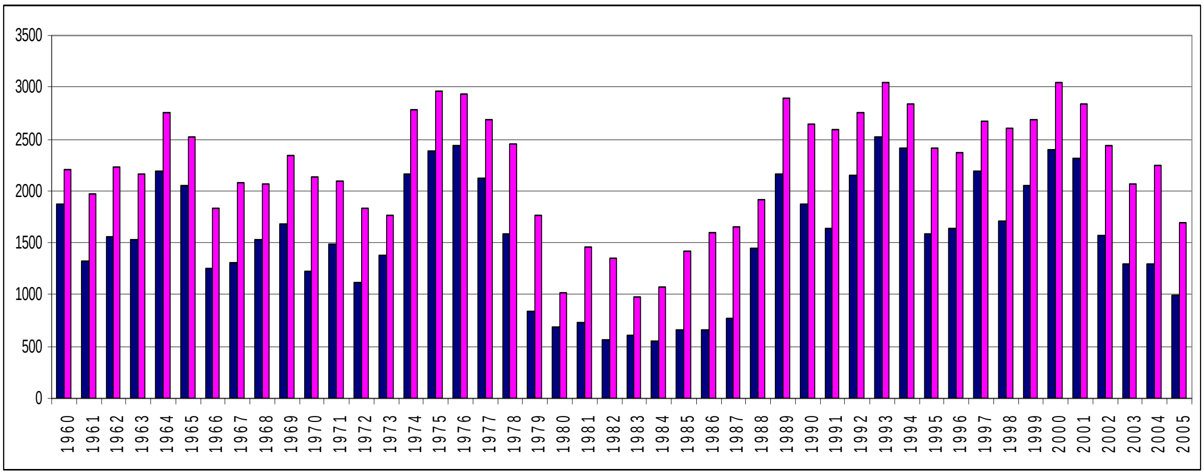


Figure 6-23: Beles hydropower - annual generated power (in GWh) for Scenario 4 (pink) and Scenario 3 (blue), 1960-2006



6.4 Scenario Analysis

Table 6-7 and Table 6-8 (Lake Tana Water Balance, Baseline Scenario) show that it is possible to use on average around 3,520 Mm^3 per year (including downstream release to the Blue Nile) without jeopardising the lake water levels.

The first two scenarios (1 and 2) show that (i) the direct impacts of MPIDP on the Lake Tana water balance will be negligible, and (ii) the cumulative impacts of any medium term irrigation development scenarios will be very low too.

The more interesting scenarios are the last two (3 and 4) involving operation of the Tana-Beles Transfer, since this was inaugurated in May 2010 and is now running.

The main factors to consider in these scenarios of Lake Tana water use are as follows:

- The Beles hydropower plant, at its full capacity, requires 160 m^3/s, or 5,046 Mm^3/year.
- The Beles irrigation schemes (as modelled in Scenario 3) will require 628 Mm^3/year, especially in the dry season - when the lake level is already lower.
- Navigation in the lake requires a minimum water level of 1,785 masl;
- The release to the Blue Nile should be more than 1,000 Mm^3/year (only for the tourism requirements of the Tis Issat Falls; environmental flows would be larger);
- Irrigation within the Lake Tana basin will require around 500 Mm^3/year (net water requirement).

The first factor is already incompatible with maintaining Lake Tana water levels[102].

A second major issue is that the demand for water for irrigation comes during the dry season, when lake levels are already low. Irrigation demands at this time may conflict with the demands of other uses such as navigation or minimum releases to the Blue Nile.

Scenario 3 illustrates a possible modification of the hydropower demand to maintain lake levels (the hydropower abstractions are only 2,194 Mm^3/year, or 43% of the full capacity requirements). However, if the irrigation abstractions are added to this amount, there is not enough renewable water to satisfy the 1,000 Mm^3/year tourism requirements of the Tis Issat Falls. This is why some unsatisfactory demands may be observed, especially during dry years when less water is available.

Scenario 4 gives the minimum release to the Blue Nile a high priority. Even if only the tourism flow (lower than estimated environmental requirements) is taken into account, this prioritisation leads to non-satisfaction of the demands for irrigation and hydropower, as well as a decrease in lake levels.

- **To conclude, the modelling tool clearly shows that it is not possible to satisfy simultaneously all the uses identified above.**

Clearly, a prioritisation exercise will have to be made for the use of the Lake Tana basin waters, taking into account all future water uses and with the participation of all the water users.

6.5 Transboundary Effects

6.5.1 The Nile

The Nile is the longest river in the world, flowing through nine countries. The Blue Nile rises in Ethiopia and flows to the Sudan. The White Nile flows though Uganda, Sudan, and Egypt. Zaire, Kenya, Tanzanian, Rwanda, and Burundi all have tributaries, which flow into the Nile or into Lake Victoria. From Lake Victoria to the Mediterranean the length of the Nile is 5,584 km. From its remotest headstream, the Ruvyironza River in Burundi, the river is 6,671 km long. The Nile Basin covers an area of more than 3,349,000 km² (Figure 6-24).

The Blue Nile (in Arabic the Al Bahr al-Azraq, known as the Abbay in Ethiopia), 1,529 km long, descends steeply from the Ethiopian Plateau (see Figure 6-25 below). The Blue Nile rises at a spring on the south side of Lake Tana at about 2,150 m asl, flowing into the lake as the Gilgel Abbay. Leaving the lake as the Tis Abbay, the river flows southeast, then south, west and north until eventually it meets the White Nile at Khartoum. From the confluence of the White and Blue Nile, the river continues to flow north into Lake Nasser, Egypt and on to the Mediterranean Sea.

The following Sections (6.5.2 and 6.5.3) show the quantitative impacts of Scenarios 3 and 4 on flows in the River Nile. As seen before (see Section 6.3), there will not be any significant impact of Scenarios 1 and 2 on the Nile waters.

6.5.2 Transboundary Impacts, Annual Scale

According to many hydrological studies, the mean flow of the Blue Nile River at the frontier between Ethiopia and Sudan, is around 50,000 Mm^3/year, and downstream, the mean flow of the Blue Nile River at the confluence with the White Nile at Khartoum is around 54,000 Mm^3/year. Therefore, the current mean flow released from Lake Tana represents about 8% of the mean flow of the Blue Nile River at the frontier.

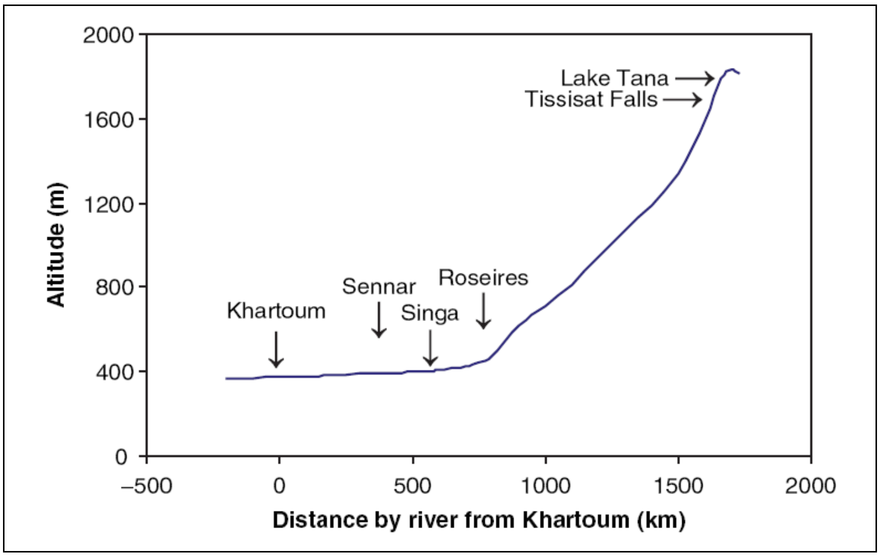
The flow of the Nile River entering into the Aswan dam's reservoir, Lake Nasser, averages some 84,000 Mm^3/year. Therefore, the current mean flow released from Lake Tana represents less than 5% of the mean flow entering into Lake Nasser.

[102] This is why the tunnel transfer has operation rules which prevent water abstraction if the lake level is too low (for instance: the operation rule adopted by Salini and Pietrangeli (2006)).

Figure 6-24 : Nile River Basin

Source: BRLi, 2009b. The underlined countries are the Nile Basin Initiative (NBI) member States.

Figure 6-25 : Longitudinal Profile of Blue Nile



Source: Vijverberg et al. (2009).

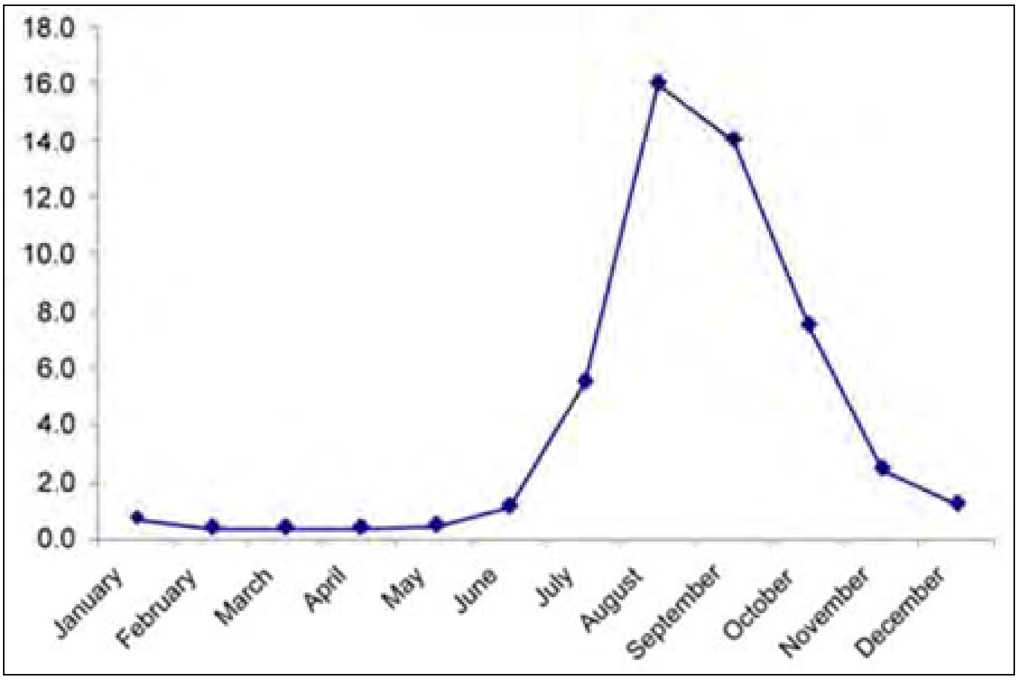
The Beles River reaches the Blue Nile upstream of the Ethiopia-Sudan frontier. Consequently water transferred to the Beles from lake Tana will still reach the border, and the only losses from the transferred water will be the consumptive uses for irrigation downstream of the Beles powerplant. According to Scenarios 3 and 4 analysed above (see Section 6.4), the net irrigation water abstractions should represent less than 1,500 Mm^3/year in the medium-term, or less than 2% of the mean flow entering Lake Nasser.

- **To conclude, at the annual scale, the development of the Tana-Beles sub-basin will not have major transboundary impacts.**

6.5.3 Transboundary Impacts, Seasonal Scale

Discharge in the Blue Nile (see Figure 6-26 and Figure 6-27 below) exhibits high seasonal variation in response to seasonal rainfall patterns in the Ethiopian highlands. According to Figure 6-27, there is also a seasonal variation in the water released from Lake Tana to the Blue Nile River.

Figure 6-26: Average monthly flows (1912 - 1982) - Blue Nile at Khartoum (km^3/mo)



Source: Said, R. 1993.

From Figure 6-26 and Figure 6-27 it is possible to say that Scenario 3 and Scenario 4 will have a very important impact on Blue Nile flows during the dry season, for the part of the river between Lake Tana and the confluence with the Beles River. This reach is totally inside Ethiopia. Flows will be reduced by more than 30% during the dry season months. At the confluence with the Beles River part of the Lake Tana waters abstracted through the Tana-Beles tunnel will be returned to the Blue Nile.

Figure 6-28 shows the total flows coming from Lake Tana and reaching the Blue Nile at Chara Chara and (via the Beles River) at the Blue Nile-Beles confluence, under various scenarios (the figure was produced by using the SMEC 2008 model). It shows that the impacts of Scenario 3 and 4 are significant at the border with Sudan during the dry season, in that the flow may be reduced by 0.2 km^3/month. This is more than one third of the observed monthly flow of the Blue Nile at the frontier from January to May.

Figure 6-27: Average monthly flows modelled in this study (1960-2006) - Blue Nile at outlet to Lake Tana (km^3/mo)

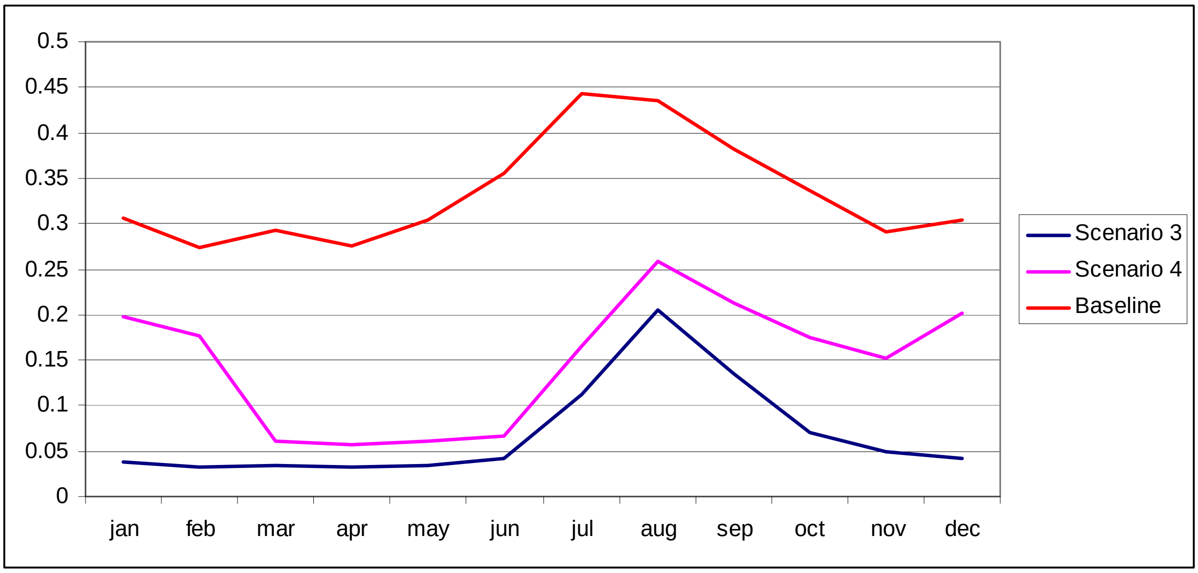
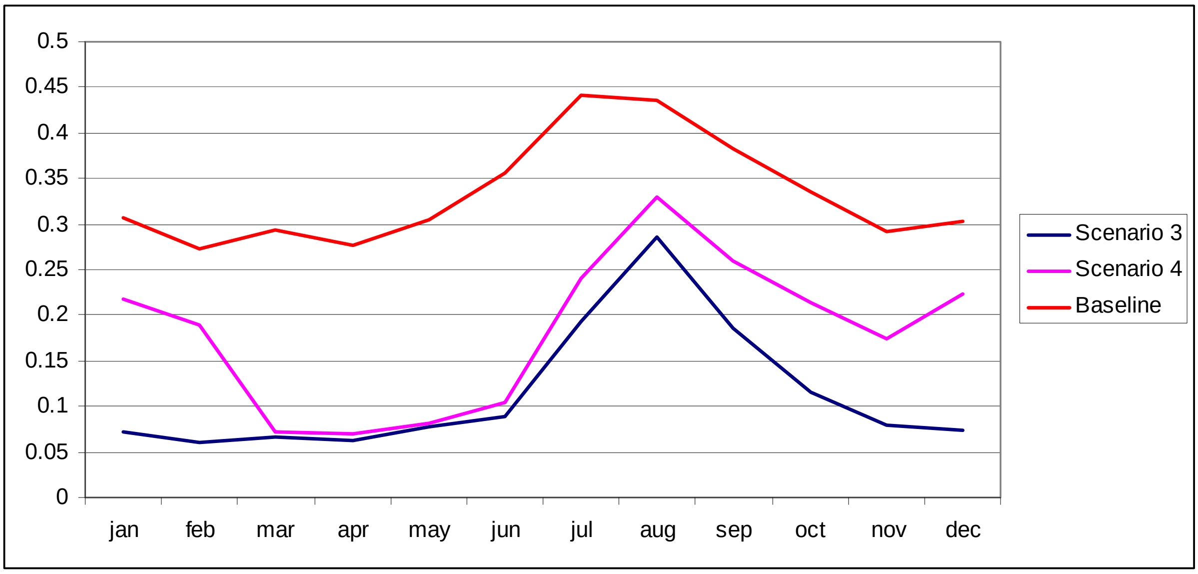


Figure 6-28: Total flows from Lake Tana reaching the Blue Nile-Beles confluence (1960-2006) (km^3/mo)



In conclusion:

- **At a seasonal scale, development of the Tana-Beles sub-basin will have major transboundary impacts during the dry season**.

This conclusion must be qualified: several major storage dams have been proposed for the Blue Nile within Ethiopia, and some are at an advanced stage of study (e.g. Mandaya). These dams will be large enough to provide significant river regulation, and an increase in dry season flows is feasible if this is determined to be appropriate.

6.6 WATER MANAGEMENT

6.6.1 Use of Transparent and Integrated DSS

So far, there is no general planning exercise and global overview available to determine the compatibility of the various planned and ongoing projects. **There is no general schedule of new projects and no integrated approach on how to make projects compatible and which mitigation measures or trade-offs to consider.** Major players in the game like EEPCo (hydropower, current operation of Chara Chara weir…) and MoWE (large irrigation schemes) are acting separately without significant apparent cross consultation and coordination. This lack is "expressed" at local scale like the Lake Tana basin in particular, and is also evident at a wider basin scale (Abbay River basin) and eventually at international level (the Blue Nile and the Nile).

At Ethiopian level, this situation stems from lack of up to date planning exercise and reliance on outdated documents like the "Abbay River Master Plan". As yet **there is no general water resources simulation model** able to shine light onto the compatibility and cross effects of various projects, and there is no independent authority able to assess and arbitrate on a general planning of water resource use.[103] Therefore the decision process is made on case-by-case projects and does not address the whole picture, today and in the future.

So far, there are few if any links established to some of the major initiatives at Nile Basin scale, such as the DSS (Decision Support System) and the next coming Eastern Nile hydraulic planning model.

The resulting **lack of transparency** (obscure decision-making processes, lack of public access to official documents (licences, operation rules), weak consultation processes) contributes to lack of confidence amongst local stakeholders, creates uncertainty, and is detrimental to development and good governance.

6.6.2 Water Monitoring System

Knowledge of water resources and their uses is an important basic function, essential to implement other functions. The status of the hydrological monitoring network in the Tana and Beles Basins was analysed in detail by SMEC (2007), who identified a number of budget-related staff and equipment shortages and other issues relating to data collection and data processing including quality data control. Budget-related problems involved[104]:

- Lack of local staff and poor involvement concerning data quality,
- Poor staff training,
- Rapid technician turnover due to poor salaries,
- Lack of staff to undertake additional tasks such as information dissemination,
- Insufficient hydrometric stations and insufficient telemetric equipment,
- Lack of data collection and processing concerning water quality and groundwater,
- Insufficient maintenance,
- Poor offices equipment in particular concerning computers and sharing of information systems (telephones, internet, server, etc.)
- Lack of research and study activities.

Consequently, there is insufficient understanding and knowledge of Lake Tana's hydrological behaviour and trends. Some basic information like water uses or lake basin hydrology, including water regime and silt loads, is still not available with the level of accuracy and precision required for reliable analysis. Many assumptions have to be made, as was done, for example, in the water allocation model used in this cumulative effects analysis.

[103] The model used in this chapter is only designed for the Tana-Beles sub-basins and does not cover all the water resources management aspects (no water quality, no groundwater…).

[104] Major problems related to the network of hydrometric stations are discussed in the report *Review and Recommendations of the Hydrological Monitoring Network* in the hydrological study of the Tana and Beles Sub-basins (SMEC, Nov. 2007).

The Tana and Beles Integrated Water Resources Development Project (TBIWRDP) is currently under implementation over a period of five years, starting in fiscal year 2008/09. It operates within the Abbay River Basin, focusing on the Tana and Beles sub-basins. The project has four components: Component A. Sub-basin Resources Planning and Management; Component B. Natural Resource Management Investments; Component C. Growth-Oriented Investment Facilitation; and Component D. Project Management. As part of Component A, MoWE is launching the Tana-Beles HIS/BIS (Hydrological Information System / Basin Information System) – the inception phase starts in July 2010. According to the ToRs, rational water resources management in the Tana and Beles sub-basins, as well as the Abbay Basin as a whole, calls for a sound "Basin" Information System (BIS) covering all water-related data, including not only all information on the characteristics and availability of water resources but also data on existing and projected water demand in all sectors, including ecological and environmental demands (stabilisation of ecological processes, provision of environmental services, biodiversity conservation, in-stream flow requirements, etc).

Implementation of the HIS/BIS will provide important data for integrated management of Lake Tana and its water resources.

6.6.3 Poor Coordination between Agricultural and Water Bureaus

This observation can also be made at Federal level, between the MoWE and the MoARD. As far as irrigation is concerned, both aspects are to be addressed at the same time, which is water management and hydraulic equipment on one hand, and agricultural extension, farmers' training, introduction of new technologies and new organization of farmers in order to manage properly the equipment. In addition, land tenure management also needs to be considered.

For this specific issue, the situation seems to be that very little or even no information is circulating between EPLAUB and BoARD at regional level. The point has been reached where some private investors have been apparently granted thousands of ha of land (Israeli Brazilian sugar project at Pawe on the Beles river) without a detailed study of the available water resources and how they might be used. The same situation seems to be happening in the Didessa Valley (Oromia). In this case, there is no chance to reach a coordinated and sound development if land allocation is done so swiftly and without even a minimal study. This kind of initiative is definitely not sustainable and contrary to the concept of IWRM and all tools under development, including the River Basin Organisations themselves.

In a different case, that of watershed management, the situation is also critical for the same reasons. It is recommended that the three bureaus involved (BoEPLAU, BoWRD, BoARD) learn to cooperate in a thorough and active manner to face the major challenges in both fields (irrigation and watershed management).

6.6.4 Water Permits and Water Monitoring

Council of Ministers Regulation No. 115/2005 dealing with Ethiopian Water Resources Management defines the duties of the permit holder and the supervising body concerning water resources utilisation permits, water works permits and waste water discharge permits, and indicates that the supervising body is allowed to take water samples (Article 12) or to ascertain the quantity of water abstracted.

In reality, this power is not exercised. The regulation ambiguously mentions both "water permits issuance" and "licensing the contractors and consultants" acting in water issues. In practice activity is limited to this second field.

This situation stems from various reasons, including that the Supervising Authority (MoWE) does not have the capacity in terms of staff and budget to ascertain quantities of water actually abstracted or do the water quality analysis. The situation is the same for the Regional Bureaus of Water Resources Development. For major abstractions, the Supervising Authority is not able to correctly ascertain the quantity of water without measurement devices located permanently at the abstraction site. Another issue lies in the fact that the regulation does not clarify how to proceed in practical terms for delivering permits. The people in charge of this activity in MoWE face a further challenge: what are the rules to be applied to deliver or refuse a permit? How about the quantity of water acceptable for abstraction? There is no model or decision support tool available which could help make the decision more scientific and understandable by all.

Together these factors are a major challenge and one that the Abbay Basin Authority (in line with its duties as defined in the proclamation) will have to tackle through the development of the necessary means and the employment and training of capable personnel of running the hydrometric network and staffing a specific department for water permits delivery.

Regulation No. 115/2005 indicates that water charges will be paid for any use allowed under the Proclamation and the Regulations to the supervising body. However, due to the absence of a permits delivery system, nobody is asked to pay water charges as the main users (in terms of quantity) in the Tana-Beles sub-basins.

6.7 CONCLUSIONS

The main cumulative effects identified in this chapter with respect to water volumes and availability are summarised in the following table.

Table 6-15: Cumulative Effects Analysis - Water Quantity and Management - Summary

Cumulative Effects	Analysis	Mitigation Options	Residual Significance
CE1: if the identified water use plans are confirmed, there will be conflicts between the water users in the medium term future.	Planned future water requirements for navigation, tourism flows, environmental flows, Beles irrigation, Lake Tana basin irrigation and Beles hydropower production cannot all be satisfied (see Section 6.4). Use of the existing DSS tools show, for example, that the Beles hydropower plans, the Lake Tana medium irrigation development, the Lake Tana water level requirement for navigation and the estimated flows for tourism at Tis Issat are not compatible.	ABA should elaborate a Lake Tana water resources management plan, together with all the stakeholders. The use of basin planning tools (such as the Tana-Beles Basin Information System) will assist the stakeholders in planning the management of the Tana Beles water system (including the prioritisation of water uses).	High adverse if not mitigated (user conflicts). Low adverse if mitigated.
CE2: poor coordination between water users will result in conflicts.	The lack of coordination (see Section 6.6.3), like the lack of clear definition of the water allocations between all users (including the environment – see Section 6.6.4 for the water permit delivery system) creates a situation where only the powerful upstream users are likely to be satisfied.	ABA should elaborate a Lake Tana water resources management plan, together with all the stakeholders. This mitigation measure will also help ABA define its responsibilities and roles (see Section 8.9.3).	High adverse if not mitigated. Nil adverse if mitigated by a strong ABA.
CE3: the environment is currently neglected because no environmental rules have been agreed by all stakeholders (such as a minimum release from Lake Tana to the Blue Nile).	The environmental flows presented in Section 6.2.2.6 above are the most recent and relevant estimation of environmental flow requirements at the outlet of Lake Tana. However, they were not derived by a formal process of negotiation involving all water stakeholders.	As part of any future Lake Tana water resources management plan, environmental flows should be decided by all the stakeholders, using objective methodologies.	High adverse if not mitigated (users' conflicts and environmental degradation). Low adverse if mitigated.

Cumulative Effects	Analysis	Mitigation Options	Residual Significance
CE4: the dry season flows of the Blue Nile River will decrease significantly because of the Tana-Beles transfer and abstractions.	As seen in Section 6.5.3, if all the planned schemes are implemented the water released from Lake Tana to the Blue Nile (from the Chara Chara weir or through the Beles River) will be reduced by 0.25 km^3/month in the dry season (more than a third of the current flow at the Ethiopia-Sudan border). These figures are extracted from the analysis of Scenarios 3 and 4 (see Section 6.3).	Increase the regulation of the Blue Nile using future dams and reservoirs (e.g. Karadobi, Mandaya, Beko Ambo and Border).	High adverse transboundary impact if not mitigated. Nil adverse if mitigated by regulation.
CE5: the system is not known well enough to enable detailed impact analysis and the development of effective mitigation measures.	As seen in Section 6.6.2, there is insufficient understanding and knowledge of Lake Tana's hydrological behaviour and trends. This prevents water users and water planners from efficiently planning the development of the Tana-Beles water system.	Implement the monitoring components of the Tana and Beles Integrated Water Resources Development Project (TBIWRDP) without delay.	High adverse if not mitigated. Nil adverse if mitigated with a functional water information system.
CE6: there is little communication concerning the importance of the sustainable use of the water resources of the fragile Lake Tana water system.	As an example, some of the stakeholders interviewed think that minimum lake levels are only preserved by the Chara Chara weir, whereas upstream abstractions, the new Beles transfer and operation of the weir are major factors in determining lake levels.	Development of any future Lake Tana water resources management plan should be a participatory process. ABA should allocate the resources necessary for effective communication.	High adverse if not mitigated. Nil adverse if mitigated by a stronger ABA.

Source: Consultant

7. Alternatives

7.1 Introduction

This chapter presents a summary of the main project options considered during the design process, for comparison with the alternative preferred by MoWE and the do-nothing or no-action scenario.

7.2 No-Action Scenario

The existing situation in the PCA is described in Chapter 4. Poverty is high, social indicators are low (education and health status), and the population is increasing. Modern technologies (small pumps) are becoming available allowing small-scale irrigation for some land users. The woreda and kebeles have plans for development in all sectors, but few resources and little capacity to implement them. Consequences include:

- No agricultural land for the younger generation.
- Drainage of wetlands and conversion of the lakeshore zone to farmland, with associated loss of ecosystem functions and livelihood services.
- Increased demand for pesticides with associated human and environmental health issues.
- Further increases in environmental pressures, such as sand mining in riverbeds, destruction of remaining wild trees and shrubs, and 100% catch of river fish by netting.
- No generation of capital or rapid movement out of poverty.

This scenario is not acceptable on either social or environmental grounds.

7.3 Alternative Development Scenarios

The PCA will not develop rapidly, or at all, without outside intervention. From a long list of possibilities, the ESIA social team identified the following two transformative actions as priorities:

1. **Provision of safe domestic water supplies to all PCA households** (by means of protected wells and shallow hand-pumps at community level, and eventually by rainwater harvesting at household level). This action would be accompanied by the necessary water quality sampling and monitoring system (with a lab at woreda headquarters), and by supported by upgrading of the health posts and their capabilities with respect to both outreach and curative treatment. The results would be a radical change in demands on women's time and in household health status, with major positive knock-on effects.

2. **Provision of easy access to inputs, advice and markets** (by means of (i) major upgrading of the extension and input supply system, and (ii) the construction and maintenance of all-weather access). The results would be a radical change in the ability of farmers to access agricultural advice and inputs and to respond rationally to market opportunities.

What is interesting about these two strategic developmental thrusts is that **they are required both with and without the project**. The project, with its high profile and objective of accelerated, transformative change, provides an exceptional opportunity to obtain ("leverage") the funds and resources needed for these complementary investments.

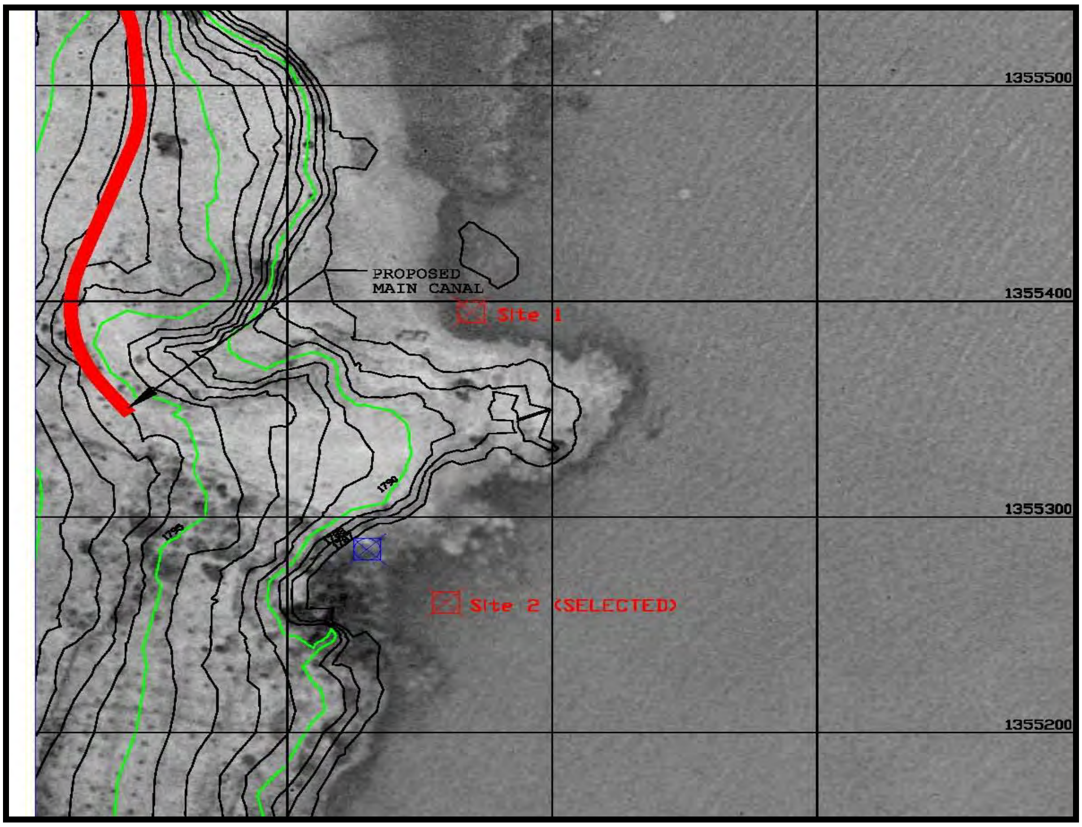
Other measures will also be required to maximise the project's benefits and ensure sustainable socio-economic development - upgrading the education system including adult literacy, livestock services, women's programmes, electrification, etc. (see Chapter 5, Impact Analysis, and Chapter 8, ESMP) - but these are of (relatively) lower priority.

7.4 Alternative Designs and Layouts

A number of alternative designs and layouts have been considered in the design process. The major options include:

- **Pumped irrigation versus gravity irrigation from the planned Megech Dam:** all water from the Megech reservoir will be allocated to areas upstream of the Megech (Seraba) command area, therefore alternative irrigation water supplies are required. The Dirma is not sufficiently large to provide water for the whole PCA, nor does it have any suitable dam sites. Pumping from the lake is the only option for irrigation of the entire area.
- **Pumping station location:** two sites were identified, one on each side of a small headland (Figure 7-1). The site selected was chosen on the basis of minimum horizontal variation in shoreline, shortest approach channel due to deeper water and steeper drop-off, protection from sediment-laden Dirma River outflows by the headland, a natural bay with minimal excavation required, good foundation conditions (bedrock), shortness of the riser pipe, and favourable topography for the headworks.

Figure 7-1: Alternative Pumping Station Locations



Source: MPIDP FS

- **Irrigation technology:** soil and water conditions in the PCA are difficult. In most of the area, especially west of the Dirma River and towards the lakeshore, it will be extremely important to minimise water applications so as to guard against the risk of groundwater rise and secondary salinisation. Pressurised irrigation is an excellent technique for managing water efficiently, but requires higher levels of investment than surface irrigation (for pumps, pipes and sprinklers), has higher running costs (more complex technology) and higher skills requirements for operation and water scheduling (see Table 5-6). Consequently MoWE has decided to establish the scheme using, initially, only surface irrigation. The risks to soil quality will be minimised (a) by excluding sensitive areas nearer Lake Tana from the scheme, (b) by prioritising drainage, and (c) by monitoring groundwater and soil quality.

  Nevertheless, in its conclusions the FS states that with surface irrigation "*Project benefits are expected to drop with time because of the development of waterlogging and salinity*." This is an important project risk.

The MPIDP FS presents these two basic technologies in three irrigation options, I, II and III. Option I comprises combined pressurised and surface irrigation (50% each), net area 4,994 ha; Option II also comprises combined pressurised and surface irrigation, this time in the ratio 25%:75% respectively, net area 4,234 ha; and Option III comprises 100% surface irrigation, net area 4,000 ha. The pros and cons of the different combinations are summarised in Table 7-1.

- **Flood management alternatives:** at present the command area is flooded to greater or lesser extent every year. This maintains soil fertility and allows flood recession agriculture, but also destroys crops and prevents access. The project intends to construct dykes (earth bunds) along the Dirma River to prevent flooding from this source, at least for 9 years out of 10. On average every 10 years floods will occur (through spillways built to protect the dykes from overtopping) and will be significant. The alternative to dyking is to allow the land to flood naturally and accept more frequent inundations. On balance, farmers in the PCA appear to prefer flood protection and have already constructed and are benefiting from dykes.
- **Command area layout:** the command area layout is determined by gravity for both irrigation and drainage, and consequently has little choice. One consideration is the inclusion or exclusion of existing settlements in the system of channelisation. The pros and cons of this are analysed in Chapter 5 (see Impact C17).
- **Road layout:** the road layout is based on a principal service road along the main canal, with access points (i) in the south near the pumping station, and (ii) from the north, at Guramba. Within the scheme subsidiary roads run mainly north-south rather than east-west. This choice reflects both the landscape, which basically drains from north to south, and economic and administrative links, which are to the market and woreda HQ of Kola Diba in the north. If funds become available in future, east-west connections could be created to link to the rest of the Dembia Plain by fording the old and new Megech river channels.

7.5 Alternative Operating Systems

Alternative operating systems considered during the design process include:

- **12-hour versus 24-hour irrigation:** 24-hour irrigation halves the flows needed to a particular location and therefore reduces investment costs for channels, but farmers have to be available at appropriate times including in darkness. It was considered unrealistic to expect efficient 24-hour irrigation under the conditions of the project area.
- **Pumping hours:** to reduce pump sizes and the size of the main canal, it was decided to pump for 20-24 hours, with water retained in night storage reservoirs to be released during the daytime irrigation period. The alternative was to double the pumping capacity and the size of the main canal, with associated costs.

Table 7-1: Pros and Cons of Proposed Irrigation Options

No.	Item	Implications for		
		Option I - Combined Irrigation	Option II - Combined Irrigation	Option III - Full Surface Irrigation
1	Land levelling and shaping	Land levelling is essential for surface irrigation to form borders and straight furrows while pressurized irrigation is adaptable to sloping and undulating land. As the command area has flat to gentle slopes the cost of levelling and shaping is not too high. The average cost of levelling in Option I will be minimal as nearly 50% of the area is under pressurized irrigation.		
2	Soil suitability	80% of the project area falls under S2W and S3W categories, which are moderately and marginally suitable for irrigation due to wetness. Selection of the irrigation method in specific areas is according to soil suitability. Some areas of Option III surface irrigation fall under the S3W category, which needs efficient water application.		
3	Depth of groundwater	The groundwater level west of the Dirma River is at 2 m bgl. All three options are planned to suit the groundwater situation. Option III (full surface irrigation) west of the Dirma River may pose some risk but it is manageable by controlling groundwater at a safe level and maintaining effective drainage.		
4	Groundwater salinity	Of the samples collected from the project area a few, in places close to seasonally flooded areas and grazing lands, show high salinity. These areas are excluded from irrigation development and left as community grazing lands.		

No.	Item	Implications for		
		Option I - Combined Irrigation	Option II - Combined Irrigation	Option III - Full Surface Irrigation
5	Drainage and flooding hazard	Due to flat to gentle slopes and low elevation close to Lake Tana, these areas are affected by poor drainage and frequent flooding. Such areas are proposed to be under pressurized irrigation. However, some damage is expected from Lake Tana high levels.	The areas east of the Dirma River close to Lake Tana below 1,787 m, which are affected every year due to high lake levels, are excluded from the proposed irrigation development. However, areas west of the Dirma River will have some drainage limitation.	This option, which has a net area of approximately 4,000 ha, is the safest against flooding hazards. Due to a better differential head between the lake and the command area, drainage will be much better.
6	Environmental challenges	Lake Tana and the area close to it are environmentally sensitive, which is taken into consideration by all three options. Option III, which proposes exclusion of lowlands close to Lake Tana and three big wetlands, is the most environmentally friendly. Although it involves some environmental risks such as waterlogging in areas west of the Dirma River, these can be controlled by maintaining the water table at a safe level by minimizing water losses and by effective drainage		
7	Water losses and efficiency	A pressurized system has better application efficiency, which results in the highest overall efficiency and better return per unit volume of pumped water.		
8	Capital cost	Investment cost for pressurized system is very high, which results in very high capital cost per ha.	The pressurized irrigation area is significantly reduced, leading to lower cost.	Per ha capital cost is the lowest as surface irrigation is proposed for the entire command area.
9	O&M cost, including pumping	O& M cost has two components, one relating to routine pumping of water from Lake Tana and the other to secondary pumping for pressurized irrigation. Option III, which involves only primary pumping, will result in lowest O&M costs		
10	Farmers' current experience and knowledge	The current level of knowledge and experience of irrigation on the part of small holding farmers in the area is limited, especially for pressurized irrigation. Thus adaptability to surface irrigation, as proposed in Option III, will be better.		
11	Land consolidation and social acceptability	At present, the entire command area is divided into small parcels, with each farmer having several small plots of varying fertility. Land redistribution for a combined irrigation system is cumbersome and its social acceptability is expected to be very poor. Option III, involving full surface irrigation, will result in the least disputes and will offer a better solution on land consolidation and social acceptability issues.		

Source: MPIDP FS Table G.2-2

- **Rotations:** various rotation periods were analysed (the length of time between waterings). The recommendation for an 8-day rotation was made on the basis of fairness, so that no farmers would have to water on Sundays more than once every two months. In practice the 8-day schedule may have to be varied to cope with differing crop combinations on the hard-to-manage vertisols.

7.6 ALTERNATIVE MANAGEMENT SYSTEMS

Alternative management systems considered include:

- **On-Farm:** two organisational frameworks were considered: Water Users' Associations (WUAs) based on villages, and WUAs based on the tertiary canal system. Village based systems would have a water management committee elected by farmers at village level, chaired by the *ye wuha abat* ("water father") and with a secretary, a treasurer and sufficient cluster leaders (*sirfege*) to service 1 to 5 blocks, depending on the size of the village. Although this would reflect existing social systems and links, it is open to influence and could face the practical problem of village boundaries not coinciding with water management boundaries (i.e. canals and drains). The alternative, WUAs based on tertiary canals, allows farmers with common cropping interests to cooperate and coordinate, has clear physical boundaries, allows farmers belong to more than one WUA if they have plots in different areas, and is less open to influence.
- **Off-Farm:** various options have been considered, including operation by government (MoWE), operation by a private sector entity on behalf of government, and deeper privatisation through some form of public-private partnership. In view of (i) the high risks and therefore low interest of the private sector in investing in the scheme's infrastructure, and (ii) government's capacity constraints, at present the preference is for the off-farm elements of the scheme to be operated and maintained by a private sector entity under a service contract. The concept of a unitary irrigation authority responsible for all services and inputs has not been considered in depth since the project is not on a greenfield site, establishment would be legally challenging for a variety of reasons, and financing would be a major issue.

8. Environmental and Social Management Plan

8.1 INTRODUCTION

8.1.1 Background

In environmental terms the MPIDP is a Schedule 1 project (Ethiopia) and a Category A project (World Bank). Accordingly, it has been the subject of a comprehensive Environmental and Social Impact Assessment (ESIA) in accordance with prevailing Ethiopian policies, laws and guidelines. The ESIA has identified a number of potential adverse environmental and social impacts associated with the project and has developed mitigation measures for these.

The ESIA has also identified (i) a number of measures required to ensure that the project's physical investment is converted into sustainable socio-economic improvements of the lives of the intended beneficiaries, (ii) two biodiversity offset initiatives (fisheries management and lakeshore restoration), and (iii) one potential enhancement measure (a measure which could improve project benefits significantly at relatively low cost, in this case aquaculture).

The project's potential adverse environmental impacts will be mitigated and its sustainability promoted by implementation of an Environmental and Social Management Plan (ESMP), prepared in accordance with the EPA's draft guidance on sectoral EMPs (EPA 2004) and with the Bank's OP 4.01 (World Bank 1999). The recommended contents of an ESMP for a Category A project are given in Box 1-1.

Typically an ESMP will contain subsidiary plans for the two broad tasks of (i) environmental, and (ii) social management. These, in turn, may be broken down into further sub-plans such as a Fisheries Management Plan, Resettlement Action Plan (RAP), or Community Development Plan. In this case, the ESMP includes two such plans, in the form of two stand-alone reports:

- Resettlement Action Plan (prepared by a different consultant and presented separately)[105]
- Phase 1 Pest Management Plan (Annex 8 of this ESIA report, in Vol. 2)

The ESMP also refers to two major sub-studies within the ESIA:

- Rapid Health Appraisal (Annex 7 of this ESIA report, in Vol. 2)
- Reconnaissance Physical Cultural Heritage Survey (Annex 9 of this ESIA report, in Vol. 2)

Preparation of this ESMP has been challenging: firstly, delivery of some of the mitigation measures require actions and responses at regional level (programmes) or national level (policies) rather than at project level; secondly, transformation of rural society through modern irrigation typically requires a multi-sectoral approach under a unified management structure (an executive authority for the scheme), but the project has not been designed for implementation by this traditional approach. The ESMP is left to fill some of the gaps that would normally be covered through a full-scale integrated rural development project preparation study. Consequently the ESMP outlines a number of measures recommended for consideration by the project proponent in order to enhance the project's sustainability. If approved, these will require further development by stakeholders after decisions have been taken on the approach to be adopted.

[105] A draft RAP became available in August 2010 (SMEC 2010). The final RAP is in preparation.

8.1.2 Approach and Objectives

The ESMP's goal is to ensure that implementation of the MPIDP complies with both Ethiopian legislation and regulations and World Bank requirements as established by the Bank's Operational Policies. Specific auditable objectives of the ESMP are listed in Table 8-1. Although "high-level", they can be quantified. They can be achieved through reaching lower level objectives by a variety of measures, tasks and activities.

Table 8-1: Higher-level Objectives of ESMP

Phase and Topic	Objective
Pre-construction	
Design	Inclusion of all mitigation measures in final project design and budget
Tendering	Inclusion of recommended measures in tender documents for both construction and construction supervision/operation.
Construction and Commissioning	
Physical	Minimised project footprint during construction.
	Restoration of all land used temporarily to equal or better condition at end of construction.
Ecological	Avoid all spillage or disposal of toxic substances to water.
	Avoid any interruption of fish migration by construction activities.
	Maintain Dirma wetlands in condition suitable for use by migratory birds throughout construction.
Social	Zero fatalities and serious accidents during construction, including from construction traffic.
	Zero increase in STD - HIV/AIDS transmission rates during construction.
	Zero unresolved complaints from local communities during construction.
	Maximised local employment, including at least 1 member of each project-affected household in "Seriously Affected" & "Most Vulnerable" categories.
Operation	
Physical	No groundwater rise, especially west of the Dirma River.
	No secondary salinisation to a level at which crop yields are affected.
Ecological	Maintenance of fish migration by healthy populations of the full suite of *Labeobarbus* species up the Dirma River and its tributaries.
	Maintenance of existing riverine wetlands as functioning habitat for (a) fish reproduction & juvenile stages, and (b) Near Threatened & migratory birds.
	Lakeshore wetland restored to species mix, area and productivity evidenced from historical records (and initially to pre 2002-conditions).
	No significant reduction in lake water quality due to agrochemical runoff from the command area.
Social	Significantly reduced labour demand on women for obtaining safe water for household use (max. 30 mins/day).
	A major reduction in the incidence of common vector-borne and communicable diseases (malaria, schistosomiasis) and an improvement in all other health indicators.
	Easy access of all households to all-weather roads connecting to the external road network.
	No exclusion of (a) women, and (b) landless and other vulnerable groups from project benefits.
Institutional	Transparent operation of representative WUAs.
	Effective, environmentally & socially sensitive operation of O&M contractor.
	Effective supply of agricultural services and inputs.
	Effective supply of non-agricultural (social) services and inputs.

Source: Consultant

The ESMP has been formulated using the following five-point approach:

- **Impact avoidance:** adjusting the project's design, construction and operation methods so as to avoid predicted negative impacts.
- **Impact minimisation:** where impacts cannot be avoided, implementing mitigation measures to reduce the impacts to insignificant levels.
- **Compensation:** where residual impacts remain significant after mitigation, arranging compensation in the form of, for example, comprehensive resettlement plans for persons affected by loss of land, assets or livelihoods, or biodiversity offsets.
- **Sustainability measures:** where certain actions are required to ensure the project's success or avoid significant risks, identifying these.
- **Enhancement:** where additional actions could be taken giving high benefit at relatively low cost, identifying these.

The measures have been formulated for implementation during (i) the current planning and tender design phase including tender document preparation (the "Pre-construction phase"), (ii) the Construction phase, and (iii) the Operation phase.

8.1.3 Structure of the ESMP

The ESMP is structured as follows:

- Section 2 lists the predicted potential adverse impacts and sustainability issues requiring mitigation at each project stage, together with an "at-a-glance" evaluation of their significance and a reference to the relevant section of the text.
- Section 3 presents the core of the ESMP in the form of three standardised tables, covering the Pre-construction, Construction and Operation Phases respectively. Note that most measures to mitigate Cumulative Effects are listed in the Operation Phase.
- Section 4 introduces the ESMP's two stand-alone sub-plans and two major sub-studies, which are given in full in the Annexes (except for the RAP, which is presented separately).
- Section 5 sets out the proposed monitoring programme, again as standardised tables.
- Section 6 outlines the recommended institutional arrangements for ESMP implementation.
- Section 7 identifies estimated costs.

To assist decision-makers, recommended "Next Steps" in environmental and social planning for the project are presented in Chapter 9.

The measures listed in the ESMP tables are mostly self-explanatory. Where additional detail is considered useful, outline ToR and summary descriptions of key tasks, mitigation measures and enhancement measures have been developed and are presented separately in Vol. 2, Annex 12.

8.2 Summary of Predicted Adverse Impacts

As specified in the ToR (Annex 11), Table 8-2 and Table 8-3 summarise the predicted adverse environmental and social impacts for which mitigation is required, by project phase and with cross-referencing to the impact analysis (Chapter 5) so that additional detail can be accessed easily.

The project's planned and anticipated *positive* impacts are summarised in Table 5-1 in Chapter 5, but not the full range of the project's expected economic benefits. These can be found in the Project Appraisal Document (WB 2007) and in the MPIDP Feasibility Study (Tahal-CECE 2010).

Note that the Construction Phase will last two years and includes a further year of Commissioning. Technically, the Operation Phase will start in Project Year 4, but in functional terms (as considered here) it will begin during Commissioning, when the system begins to physically operate.

Table 8-2: Summary - Predicted Adverse Impacts requiring Mitigation, Construction Phase

No.	Topic	CONSTRUCTION PHASE Impact	Significance* None/ Low	Medium	High	Reference in text
Construction Process						
C1	Contractor's Camps	Temporary loss of land and inadequate physical and social management of camps and workforce		•		5.3.2.1
C2	Construction Access & Traffic	Unsafe access routes and construction traffic		•		5.3.2.2
C3	Construction Materials	Permanent loss of land and health & safety hazards of operation and closure of borrow pits and quarries Hazards from toxic materials Procurement from non-environmentally & socially sensitive suppliers	 •	• •		5.3.2.3
C4	Spoil Disposal	Improper disposal and treatment of dump sites	•			5.3.2.4
C5	Waste Management and Pollution	Improper disposal of solid and liquid wastes Spills and inadequate clean-up		• •		5.3.2.5
C6	Dust	Dust nuisance or hazard	•			5.3.2.6
C7 C8	Health and Safety	Hazards to workers Hazards to public		• •		5.3.2.7 5.3.2.8
C9	Flooding during Construction	Hazards to works from floods		•		5.3.2.9
Ecology						
C10	Loss of Habitat	Direct loss of habitat		•		5.3.3.1
C11	Impact on Wetlands	Habitat impacts due to channelisation, construction in rivers & wetlands, invasive species		•		5.3.3.2
C12	Impact on Wildlife	Disturbance and exploitation during construction		•		5.3.3.3
Socio-economy						
C13	Cultural Heritage	Impacts on known & unknown physical cultural heritage		•		5.3.4.1
C14	Rapid Change	Social dislocation and social resistance			•	5.3.4.2
C15	Land Loss	Permanent loss of land & other assets for infrastructure			•	5.3.4.3
C16	Land Redistribution	Disruption of livelihoods due to reallocation and consolidation of land			•	5.3.4.4
C17	Village Irrigation	Disruption of settlements & associated impacts & health hazards			•	5.3.4.5
C18	Disruption of Existing Agriculture	Disruption of crop and livestock production by construction activities			•	5.3.4.6
C19	Disruption of Access	Disruption of existing access due to new channels			•	5.3.4.7
C20	Employment	Employment of outsiders		•		5.3.4.8

* Significance: before mitigation, Consultant's professional opinion; see text in Chapter 5 for analysis.

Source: Consultant

Table 8-3: Summary - Predicted Adverse Impacts requiring Mitigation, Operation Phase

No.	Topic	OPERATION PHASE Impact	Significance* None/Low	Significance* Medium	Significance* High	Reference in text
Agricultural Feasibility						
O1	Agricultural Feasibility	Potential delay in irrigated agriculture development			•	5.4.2.1
O2	Agricultural Sustainability	Delayed uptake of benefits due to inability to meet on-farm soil & water management needs - labour, equipment and skills			•	5.4.2.2
Soil & Water Management						
O3	Soil Management	Water use inefficiency			•	5.4.3.1
O4		Inadequate drainage			•	5.4.3.2
O5		Groundwater rise and secondary salinisation			•	5.4.3.3
O6		Decline in soil fertility		•		5.4.3.4
O7		Impact of vertisols on structures	•			5.4.3.5
O8	Erosion	Erosion in command area & sedimentation from upstream		•		5.4.3.6
Hydrology & Water Quality						
O9	Hydrology	Continuing impacts from floods		•		5.4.4.1
O10		Climate change	•			5.4.4.2
O11	Water Quality	Pollution from agrochemicals, salts, & waste			•	5.4.4.3
Pests & Diseases						
O12	Pests & Diseases	Changes in pests and diseases			•	5.4.5.1
O13	Pesticides	Inadequate pest management and improper use of pesticides			•	5.4.5.2
Ecology						
O14	Ecology	Habitat degradation			•	5.4.6.1
O15		Ongoing impacts on globally important birds			•	5.4.6.2
O16		Impacts on other wildlife	•			5.4.6.3
O17		Introduction of invasive species	•			5.4.6.4
O18		Reduced agrobiodiversity	•			5.4.6.5
O19		Increased stress on lakeshore zone			•	5.4.6.6
O20	Fish	Changes in river flows and morphology			•	5.4.7.1
O21		Fish entrainment at pumping station	•			5.4.7.2
O22		Impact of water pollution		•		5.4.7.3
Socio-economy						
O23	Social change	Cultural constraints on social and economic change			•	5.4.8.1
O24	Gender	Impacts on women			•	5.4.8.2
O25	Livestock Husbandry	Impacts of transformation of livestock husbandry system			•	5.4.8.3
O26	Energy	Inadequate fuelwood and energy			•	5.4.8.4
O27	Access	Changes in local access & barrier effects of new channels External links & road maintenance			•	5.4.8.5
O28	Benefits and Equity	Inequitable distribution of benefits - incomes and employment			•	5.4.8.6

No.	Topic	OPERATION PHASE Impact	Significance*			Reference in text
			None/Low	Medium	High	
O29		Price reductions in local markets and associated impacts on rain-fed producers		•		5.4.8.7
O30	Health	Extended malaria season			•	5.4.9.1
O31		Increased schistosomiasis			•	5.4.9.2
O32		Changes in other diseases		•		5.4.9.3
O33		Impact of continuing poor health on beneficiaries' ability to benefit from project		•		5.4.9.4
O34		Inadequate water, sanitation and hygiene reducing project benefits			•	5.4.9.5
O35		Safety hazards	•			5.4.9.6
Institutional						
O36	On-farm management	Ineffective operation of WUAs			•	5.4.10.1
O37	Off-farm management	Risks of experimental O&M model			•	5.4.10.2
O38	Services and inputs for agriculture	Reduced project benefits due to inadequate provision of essential agricultural services & inputs including research, knowledge, credit, crop storage and processing, and links to markets			•	5.4.10.3
O39	Social services and infrastructure	Reduced project benefits die to inadequate provision of essential social services, especially health, water and sanitation, also education, road maintenance, electricity and telecommunications			•	5.4.10.4
Economic						
O40	Markets	Market inelasticity affecting economics of entire project			•	5.4.11.1
O41	O&M costs	Unaffordable O&M costs			•	5.4.11.2
O42	Capital and operating costs of scheme	Under-funding of costs of compensation and resettlement, agricultural research, extension services & farmer training, equipment, environmental & social mitigation and monitoring, etc.			•	5.4.11.3
CUMULATIVE EFFECTS						
CE1	Hydrology	Insufficient water to satisfy all planned uses			•	6.7
CE2		Conflicts between users due to inadequate coordination			•	6.7
CE3		No environmental flows available for Abbay River (Blue Nile)			•	6.7
CE4		Reduced dry-season flows in Blue Nile at the border with Sudan			•	6.7
CE5		Inadequate information and data for accurate planning			•	6.7
CE6		Low knowledge and understanding of system			•	6.7

***** Significance: before mitigation, Consultant's professional opinion; see text in Chapter 5 for analysis.

Source: Consultant

8.3 ESMP - TABLES

Note: for full explanation of the cost estimates in the tables, please refer to Section 8.7.

8.3.1 Pre-Construction Phase

Solutions to many of the project's impacts and sustainability issues should be planned and/or implemented before construction starts. These mitigation measures are listed in Table 8-4.

The numbering system for the potential impacts in the table is the same as that in the impact analysis (Chapter 5) and in the two summary tables above (Table 8-2, Table 8-3).

The recommended mitigation measures are prefixed with "**P**" to indicate that they should be carried out during Pre-construction. "**PC**" refers to measures to mitigate, in advance, potential impacts predicted to occur during the Construction Phase. "**PO**" refers to measures to mitigate, in advance, potential impacts predicted to occur during the Operation Phase.

Recommendations for the tender documents for both the Supervision Consultant ("the Engineer", in this case the PSP contractor) and the Construction Contractor ("the Contractor") are given in Annexes 10.1 and 10.2, respectively.

Notes on Pre-Construction Phase Costs:

- The estimated costs in Table 8-4 are given as "Nil" or "Management overhead" where the measure can be carried out under existing contracts or is a normal task of the project proponent. In reality there will be a small professional and/or managerial time element involved.
- The estimated costs given for Measures PO25.1 (development of livestock programme), PO25.3 (development of mechanisation programme), PO33.1 (development of health programme) and PO39.1 (development of non-agricultural services and infrastructure programme) cover technical assistance to facilitate full formulation, agreement on and costing of the respective programmes, but not the cost of the programmes themselves.
- Rounded figures of USD 2,000 and USD 20,000 are used to represent 1 national specialist-month and 1 international specialist-month, respectively.

Table 8-4: ESMP for MPIDP: Pre-Construction Phase

Project Activity or Topic	No.	Potential Impact	Recommended Mitigation Measures, Pre-Construction	Timing	Institutional Responsibilities	Estimated Cost (USD '000)
Pre-Construction Phase						
To mitigate Construction Impacts						
Contractor's Camps	C1	Temporary land loss and impacts of inadequate physical and social management of camps	PC1.1 Use land of lowest value: identify sites and apply RAP procedures.	Before construction contractor mobilisation	MoWE / Dembia Woreda	Nil
			PC1.2 Include affected land users in RAP compensation packages, and establish mandatory process for user identification and compensation (note: this has been done).	During RAP preparation	MoWE	Nil
			PC1.3 Include a requirement in the tender documents for the construction contractor to employ full time Community Relations Officer and establish a formal Social Responsibility system.	During tender doc. preparation	MoWE	Nil
			PC1.4 Consider future permanent use of contractor's temporary facilities.	During tender design	MoWE / Dembia Woreda	Nil
Construction Access & Traffic	C2	Unsafe access routes and construction traffic	PC2.1 Consider including repairs to and maintenance of the Kola Diba to Guramba road in the construction or PSP contract (see Measures PO27.2, PO27.3).	-	-	-
			PC2.2 Develop mandatory procedures for negotiating rights of way for temporary access as part of RAP.	During RAP preparation	MoWE	Nil
			PC2.3 Include requirement for a comprehensive Traffic Management Plan in construction contract.	During RAP preparation	MoWE	Nil
Construction Materials	C3	Hazards from use of asbestos	PC3.1 Ban use of asbestos in all forms.	During tender doc. preparation	MoWE	Nil

Project Activity or Topic	No.	Potential Impact	Recommended Mitigation Measures, Pre-Construction	Timing	Institutional Responsibilities	Estimated Cost (USD '000)
Pre-Construction Phase						
		Procurement from non-environmentally & socially responsible suppliers	PC3.2 Give preference to goods and services sourced from organisations implementing an EMS and/or Corporate Social Responsibility approach.	During tender doc. preparation	MoWE	Nil
Health and Safety	C7	Hazards to workers	PC7.1 Project proponent and financier signal that best practice H&S standards should apply.	Prior to bidding	MoWE / World Bank	Nil
			PC7.2 Include best practice health and safety provisions in the construction contract together with (i) appropriate BoQ pay items and (ii) a financial penalty mechanism.	During tender doc. preparation	MoWE	Nil (but see notes above)
			PC7.3 Include H&S supervision and compliance in the supervision contract as a specific task, with adequate staff resources, and possibly with Employer training.	During tender doc. preparation	MoWE	Nil
	C8	Hazards to public	PC8.1 Design an HIV/AIDS prevention programme to be ready at project start-up, possibly through the construction or PSP contracts (see PO33.1).	-	-	-
Ecology	C11	Impacts of construction in rivers and wetlands	PC11.1 Ensure tender documents include specific provisions relating to contractor's equipment and invasive species.	During tender doc. preparation	MoWE	Nil
Cultural Heritage	C13	Damage to known and unknown heritage	PC13.1 Include survey by ARCCH prior to start of physical construction in MSC tender documents (this has been done).	During tender doc. preparation	MoWE	Nil
			PC13.2 Include chance finds procedures in tender documents.	During tender doc. preparation	MoWE	Nil
			PC13.3 Include regional and woreda Culture, Tourism & Parks Development offices on the respective Project Implementation Teams.	Pre-construction	MoWE	Nil
Rapid Change	C14	Social dislocation and social resistance	PC14.1 Intensive social preparation, especially accelerated WUA formation (see Measure PC18.1).	-	-	-

Project Activity or Topic	No.	Potential Impact	Recommended Mitigation Measures, Pre-Construction	Timing	Institutional Responsibilities	Estimated Cost (USD '000)
Pre-Construction Phase						
Land Loss	C15	Permanent loss of agricultural land and other assets	PC15.1 Implementation of comprehensive, gender-sensitive land acquisition, compensation and resettlement programme including payment of compensation for crops, trees, assets (see also Measure PC16.1).	Pre-construction	MoWE / BoEPLAU	See RAP
			PC15.2 Include non-landowners in compensation process and entitlements.	Pre-construction	MoWE / BoEPLAU	See RAP
			PC15.3 Provide replacement land to affected land users (see Impact C16 and associated measures).	Pre-construction	BoEPLAU / Woreda	See RAP
Land Redistribution	C16	Disruption of livelihoods due to reallocation & redistribution of land	PC16.1 Extend RAP procedures, training and support to include land redistribution as well as land acquisition.	Pre-construction	MoWE / BoEPLAU	See RAP
			PC16.2 Prioritise gender issues in land reallocation to avoid inequities and impoverishment.	Pre-construction	MoWE / BoEPLAU	See RAP
			PC16.3 Consider landless when developing land redistribution strategy (see also Measure PC18.2).	Pre-construction	MoWE / Woreda / BoEPLAU / PSP contractor	See RAP
			PC16.4 Ensure that final plot allocations reflect locally-perceived soil types (see also Measure PC14.1).	Pre-construction	MoWE / Woreda / BoEPLAU / PSP contractor	See RAP
Village Irrigation	C17	Disruption of settlements & associated impacts & health hazards	PC17.1 Revise project concept to omit channels through settlements.	During tender design	MoWE	Management overhead
Disruption of Existing Agriculture	C18	Disruption of crop and livestock production by construction activities	PC18.1 Accelerate the establishment of WUAs so that their leaders can be involved in project planning and construction from the earliest possible date (see also Measures PC14.1 and PO24.2).	Pre-construction	MoWE / BoWRD / BoARD / Woreda / PSP contractor / ENIDP Component 3	50
			PC18.2 Expand the vulnerable household lists to include *all* vulnerable households in the command area.	Pre-construction.	MoWE / Kebeles	See RAP

Project Activity or Topic	No.	Potential Impact	Recommended Mitigation Measures, Pre-Construction	Timing	Institutional Responsibilities	Estimated Cost (USD '000)
Pre-Construction Phase						
Employment	C20	Employment of outsiders	PC20.1 Social preparation and the inclusion of recruitment eligibility into RAP compensation packages.	Pre-construction	MoWE / Woreda	Management overhead
			PC20.2 Include preferential local / PAP hiring provisions in construction tender documents.	During tender doc. preparation	MoWE	Nil
To mitigate Impacts during Operation						
Agricultural Feasibility	O1	Potential delay in irrigated agriculture development	PO1.1 Full scale trial on site for at least 1 full agricultural year (2.0 ha, 8 farmers).	Pre-construction	ARARI / BoARD	40
Soil & Water Management	O4	Inadequate drainage	PO4.1 Exclude the most drainage-sensitive areas from the scheme (note: this has been done)	Pre-construction	MoWE	Nil
			PO4.2 Check Flood Risk Study to confirm lake levels for 10-year flood design.	Pre-construction	MoWE	Management overhead
	O5	Groundwater rise and secondary salinisation	PO5.1 Ensure that the recommended full scale farming trial (Measure PO1.1) includes detailed soil and water monitoring.	Pre-construction	BoARD / ARARI	10
	O6	Decline in soil fertility	PO6.1 Include fuelwood sub-component in project design to reduce use of manure as fuel (see Measure PO26.1).	-	-	-
	O7	Effect of vertisols on structures	PO7.1 Design all structures to resist damage by soil heave.	During tender design	MoWE	Nil
Pest & Diseases	O12	Changes in pests & diseases	PO12.1 Targetted research on key crop pests and diseases.	Pre-construction, Construction and Operation	ARARI / ENIDP Component 2	25
Ecology	O14	Habitat degradation	PO14.1 Ensure that the detailed design maintains effective hydraulic connections between Dirma River, its tributaries and wetlands.	During detailed design	MoWE	Nil
Gender	O24	Impacts on women	PO24.1 Ensure project design includes significant programme of gender-sensitive social interventions (see Impact O24 and associated measures).	Pre-construction	MoWE / BoWYCA	Management overhead

Project Activity or Topic	No.	Potential Impact	Recommended Mitigation Measures, Pre-Construction	Timing	Institutional Responsibilities	Estimated Cost (USD '000)
Pre-Construction Phase						
			PO24.2 Ensure that women are fully represented in WUAs by establishing mechanisms to ensure this (see also Measure PC18.1).	Pre-construction	MoWE / PSP contractor / BoWYCA	Management overhead
Livestock Husbandry	O25	Impacts of transformation of livestock husbandry system	PO25.1 Develop a comprehensive practical livestock programme and integrate this into the project design as a major project component (see also Impact O38).	Pre-construction	MoWE / BoARD	20
			PO25.2 Consider designating land between future flood dykes as communal grazing.	Pre-construction	BoARD / Woreda	Management overhead
			PO25.3 Develop a formal mechanisation policy and programme for the project (see also Impact O38).	Pre-construction	MoWE / MoARD / BoARD	10
Energy	O26	Inadequate fuelwood and energy supply	PO26.1 Ensure project design includes significant programme to enhance fuelwood supplies (see Annex 12 for outline scope of fuelwood programme).	Pre-construction	MoWE / MoARD / BoARD	Management overhead
Access	O27	Changes in local access, barrier effects, external links & road maintenance	PO27.1 Designate all projects roads as all-weather, and design them to this standard (including 'community roads').	During tender design	MoWE	Management overhead
			PO27.2 Include construction of the Guramba to Kola Diba link road in the construction contract.	During tender doc. preparation	MoWE	Management overhead
			PO27.3 Ensure the O&M contract includes road maintenance as far as the Kola Diba - Gorgora road.	During tender doc. preparation	MoWE	Management overhead
Benefits & Equity	O28	Inequitable distribution of benefits - incomes and employment	PO28.1 Pay special attention to women during the land reallocation process (see Measure 16.2).	-	-	-
Health	O30	Extended malaria season	PO30.1 Design all channels to maintain flows of > 0.1 m/s to discourage mosquito larvae.	Pre-construction	MoWE	Management overhead
			PO30.2 Exclude settlements from irrigation development (see Measure PC17.1).	-	-	-

Project Activity or Topic	No.	Potential Impact	Recommended Mitigation Measures, Pre-Construction	Timing	Institutional Responsibilities	Estimated Cost (USD '000)
Pre-Construction Phase						
	O33	Low health status reducing project benefits	PO33.1 Ensure project includes a significant health programme to mitigate negative health impacts and improve the health status of residents, developed with the full participation of the ANRS BoH (see Annex 7 for Rapid Health Appraisal and associated recommendations).	Pre-construction	MoWE / BoH	20
	O34	Inadequate water, sanitation & hygiene reducing project benefits	PO34.1 Ensure project includes a comprehensive programme to provide safe water near and in all settlements (see Impact O34; see Annex 12 for outline scope of water supply programme).	Pre-construction	MoWE / BoWRD	Management overhead
	O35	Safety hazards	PO35.1 Design Dirma River siphon trash rack to exclude children and minimise risk of being trapped against the bars (note: this has been done).	Pre-construction	MoWE	Nil
			PO35.2 Avoid construction of water-filled channels through settlements (see Measure PC17.1).	-	-	-
On-farm Management	O36	Ineffective operation of WUAs	PO36.1 Provide PSP contractor with adequate resources for an effective, intensive WUA support programme (see Measure PC18.1).	-	-	-
			PO36.2 Accelerate WUA establishment so that leaders and members can be involved in system planning and construction (see Measure PC18.1).	-	-	-
Off-farm Management	O37	Risks of experimental O&M model	PO37.1 Ensure that the PSP contractor's contract provides sufficient incentives and legal clarity for effective performance.	Pre-construction	MoWE	Nil
Services and Inputs for Agriculture	O38	Reduced project benefits due to ineffective provision of essential agricultural services & inputs including research, knowledge, credit, crop storage and processing, and links to markets	PO38.1 Clarify the project management structure to ensure that it includes an effective executive and technical office or alternative efficient delivery mechanism capable of planning and organising delivery of *all* the agricultural services and inputs required for scheme success, over and above the three Action Plans developed by NIRAS.	Pre-construction	MoWE / BoARD / ARARI / ENIDP Components 2, 3	Management overhead
			PO38.2 Include service delivery as an option in the PSP contractor's contract.	Pre-construction	MoWE	Nil

Project Activity or Topic	No.	Potential Impact	Recommended Mitigation Measures, Pre-Construction	Timing	Institutional Responsibilities	Estimated Cost (USD '000)
Pre-Construction Phase						
Social Services & Infrastructure	O39	Reduced project benefits due to ineffective provision of essential social services, especially health, water and sanitation, education	PO39.1 Develop a comprehensive plan for non-agricultural service and infrastructure delivery (safe water, health, education, etc.).	Pre-construction	MoWE / ANRS agencies / Woreda	20
Capital & Operating Costs of Scheme	O42	Under-funding of costs of resettlement and social support, agricultural research, extension services & farmer training, equipment, environmental & social mitigation and monitoring, etc.	PO42.1 Review overall project concept and plan to ensure that it includes *all* the measures necessary for effective implementation and for environmental and social sustainability.	Pre-construction	MoWE / World Bank	Management overhead

Source: Consultant.

8.3.2 Construction Phase

The following Table 8-5 lists mitigation measures recommended for implementation during construction. The table uses the same numbering system for the potential impacts as in the impacts chapter, Chapter 5.

In addition to measures required to mitigate Construction Phase impacts, the table includes a number of measures intended to mitigate Operation Phase impacts and Cumulative Effects.

The recommended mitigation measures are prefixed with "**C**" to indicate that they should be carried out during the Construction Phase. "**CO**" refers to measures to mitigate, in advance, potential impacts predicted to occur during project Operation. "**CE**" refers to measures to mitigate Cumulative Effects.

Recommendations for the tender documents for both the Supervision Consultant ("the Engineer", in this case the PSP contractor) and the Construction Contractor ("the Contractor") are given in Annexes 10.1 and 10.2, respectively.

Notes on Construction Phase costs:

- The estimated costs in this table are given as "Nil" or "Management overhead" where the measure can be carried out under existing contracts or is a normal task of the proponent. In reality there will be a small professional and/or managerial time element involved.
- "Nil" also includes standard best practice for many construction activities.
- Note that many of the measures to be implemented by the Construction Contractor are categorised as "Contractor's overheads". This conforms with the current version of the construction contract tender documents, but is not consistent with the ESIA recommendation that at least some of the health, safety, labour welfare, environmental protection and social provisions of the contract should be pay items in order to promote quality and performance (see Annex 10.2). A nominal lump sum of USD 100,000 has been allocated to cover health & safety (Measure C7.1).
- A nominal lump sum of USD 30,000 has been allocated to Measure C8.2: HIV/AIDS prevention for local residents. Actual costs may be different, depending on the scope of the programme finally agreed between MoWE, the construction contractor and the ANRS BoH.
- Rounded figures of USD 2,000 and USD 20,000 are used to represent 1 national specialist-month and 1 international specialist month, respectively.

Table 8-5: ESMP for MPIDP: Construction Phase

Project Activity or Topic	No.	Potential Impacts	Recommended Mitigation Measures, Construction	Timing	Institutional Responsibilities	Estimated Cost (USD '000)
Construction Phase						
Construction Process						
Contractor's Camps	C1	Temporary loss of land and inadequate physical and social management of camps and workforce	C1.1 Apply best practices for site management including social aspects (see also Measure C13.5).	Full contract duration	Construction contractor	Contractor's overhead
			C1.2 Remove all temporary facilities and restore land to original condition or better.	Prior to end of contract	Construction contractor	Contractor's overhead
Construction Access & Traffic	C2	Unsafe access routes and construction traffic	C2.1 Maximise use of future permanent roads for site access.	Full contract duration	Construction contractor	Nil
			C2.2 Prevent all site access through wetlands.	Full contract duration	Construction contractor / PSP contractor	Nil
			C2.3 Negotiate temporary access with all affected users in accordance with mandatory RAP procedures (see also Measure C13.5).	Full contract duration	Construction contractor / Woreda	Management overhead
			C2.4 Record condition of all roads and temporary access routes before use.	Full contract duration	Construction contractor	Management overhead
			C2.5 Make good all damage to public roads.	Full contract duration	Construction contractor	Contractor's overhead
			C2.6 Restore all temporary access routes to previous condition or better.	When not needed & prior to end of contract	Construction contractor	Contractor's overhead
			C2.7 Include all above measures and others (see Section 5.3.2.2) in Traffic Management Plan, and implement plan (see also Measure C8.1).	Full contract duration	Construction contractor	Contractor's overhead

Project Activity or Topic	No.	Potential Impacts	Recommended Mitigation Measures, Construction	Timing	Institutional Responsibilities	Estimated Cost (USD '000)
Construction Phase						
Construction Materials	C3	Land & health hazards of borrow pits and quarries	C3.1 Maximise the re-use of excavated materials in the works, as fill.	Full contract duration	Construction contractor	Nil - standard best practice
			C3.2 Site (locate) quarries and borrow pits so as to minimise impacts on existing land users.	Full contract duration	Construction contractor	Nil - standard best practice
			C3.3 Obtain archaeological clearance for all proposed borrow pits and quarries (see Measure C13.5).	-	-	-
			C3.4 Strip and stockpile topsoil from borrow pits and quarries for use in site restoration.	Full contract duration	Construction contractor	Nil - standard best practice
			C3.5 Operate quarries and borrow pits to (a) avoid creation of hazardous slopes, (b) avoid creation of malarial pools.	Full contract duration	Construction contractor	Nil - standard best practice
			C3.6 Close all borrow pits and quarries in accordance with an approved plan to maximise future use and minimise health and safety hazards.	When not needed & prior to end of contract	Construction contractor	Contractor's overhead
			C3.7 Ensure sand is only sourced from sources with ANRS BoEPLAU and Woreda approval.	Full contract duration	Construction contractor	Nil - standard best practice
Spoil Disposal	C4	Improper disposal and treatment of dump sites	C4.1 Maximise the re-use of all excavated materials in the Works (see Measure C3.1).	-	-	-
			C4.2 Dispose of spoil only at designated sites and by approved methods; methods must consider topsoil conservation and quality, and long-term soil stability against shrinking and swelling.	Full contract duration	Construction contractor	Nil - standard best practice
			C4.3 Avoid siting spoil dumps close to watercourses or in wetlands.	Full contract duration	Construction contractor	Nil - standard best practice
			C4.4 Obtain archaeological clearance for all potential spoil disposal sites (see Measure C13.5).	-	-	-
Waste Management and	C5a	Improper disposal of solid and liquid wastes	C5.1 Design and implement formal Site Waste Management Plan.	Full contract duration	Construction contractor	Nil - standard best practice

Project Activity or Topic	No.	Potential Impacts	Recommended Mitigation Measures, Construction	Timing	Institutional Responsibilities	Estimated Cost (USD '000)
Construction Phase						
Pollution	C5b	Pollution	C5.2 Apply best practice and standard operating procedures (SOPs) to minimise risk of spills (inc. secondary containment of fuel stores, vehicle maintenance on concrete pads with oil and grease traps, avoidance of refuelling within 25 m of watercourses, etc).	Full contract duration	Construction contractor	Nil - standard best practice
			C5.3 Apply SOPs to all work in or near water including Lake Tana, based on ecological clearance with respect to birds and fish (based on seasonality), minimising wading (equipment passing through or working in water), ensuring all equipment is clean and free from leaks, and maintaining natural flows through the works (if applicable) (see also Measures C11.1 and C11.3).	Full contract duration	Construction contractor	Nil - standard best practice
	C5c	Inadequate clean-up	C5.4 Ensure spill kits and containment systems are available at site and in vehicles.	Full contract duration	Construction contractor	Contractor's overhead
			C5.5 Train staff in application of SOPs, use of spill kits and emergency procedures.	Full contract duration	Construction contractor	Contractor's overhead
Dust	C6	Dust nuisance or hazard	C6.1 Identify dust-sensitive locations on unpaved roads and access tracks (settled areas) and establish and enforce maximum vehicle speeds through these.	Full contract duration	Construction contractor	Nil - standard best practice
			C6.2 Water exposed surfaces and access routes in dry season to prevent dust nuisance.	Full contract duration	Construction contractor	Contractor's overhead
			C6.3 Re-vegetate all exposed soil surfaces (see Measure CO8.1).	-	-	-
Health and Safety of Workers	C7	Hazards to workers	C7.1 Implement full H&S and labour welfare programme.	Full contract duration	Construction contractor / PSP contractor	Contractor's overhead
			C7.2 Establish and operate an emergency evacuation procedure for casualties.	Full contract duration	Construction contractor	Contractor's overhead

Project Activity or Topic	No.	Potential Impacts	Recommended Mitigation Measures, Construction	Timing	Institutional Responsibilities	Estimated Cost (USD '000)
Construction Phase						
			C7.3 Test all workers on recruitment and provide anti-retrovirals to all HIV+ personnel.	Full contract duration	Construction contractor / PSP contractor	Contractor's overhead
			C7.4 Implement HIV/AIDS and STD awareness and prevention programme for workers including free condoms.	Full contract duration	Construction contractor / PSP contractor	Contractor's overhead
			C7.5 Implement alleviation programme for site staff and labour and their families concerning STDs and HIV/AIDS.	Full contract duration	Construction contractor / PSP contractor	Contractor's overhead
			C7.6 Establish links to Dembia Woreda Health Office for local HIV/AIDS campaigns and to minimise prostitution and new brothels.	Full contract duration	Construction contractor / PSP contractor / Woreda Health Office (WorHO)	Management overhead
Health & Safety of Public	C8	Hazards to public	C8.1 Establish and enforce Code of Conduct for all project drivers including subcontractors and suppliers (see also Measure C2.7).	Full contract duration	Construction contractor	Nil - standard best practice
			C8.2 Implement HIV/AIDS and STD awareness and prevention programme for local residents targeted at specific risk groups (see also Measures C7.4, C7.5, C7.6).	Full contract duration	Construction contractor / BoH / WorHO	30 (actual TBD through Measure PO33.1)
			C8.3 Use regulations to minimise the opening of new brothels to service the workforce (see Measure C7.6).	-	-	-
Flooding during Construction	C9	Hazards to works from floods	C9.1 Confine work on at-risk channels and structures to the dry season.	Full contract duration	Construction contractor	Nil - standard best practice
			C9.2 Re-vegetate all exposed surfaces at the first opportunity (see Measure CO8.1).	-	-	-
Ecology						

Project Activity or Topic	No.	Potential Impacts	Recommended Mitigation Measures, Construction	Timing	Institutional Responsibilities	Estimated Cost (USD '000)
Construction Phase						
Loss of Habitat	C10	Direct loss of habitat	C10.1 Avoid construction in rivers and other watercourses during the period of fish migration (June - Sept.).	Full contract duration	Construction contractor	Nil - standard best practice
			C10.2 Avoid *all* construction activities within key habitats, especially (i) Dirma River wetlands, (ii) lakeshore wetland (see also Impact C12).	Full contract duration	Construction contractor	Nil - standard best practice
			C10.3 Identify and mark limits of construction zones, and keep all activity within marked boundaries.	Full contract duration	Construction contractor / PSP contractor / BoEPLAU	Nil - standard best practice
Impacts on Wetlands	C11	Habitat impacts due to channelisation and construction in rivers and wetlands	C11.1 Develop and implement SOPs for working in and near Lake Tana to avoid pollution by oils, sediment and underwater blasting (see Measures C5.2 and C5.3).	-	-	-
			C11.2 Carry out all works elsewhere in the dry season (see Measure C10.1).	-	-	-
			C11.3 Maintain uninterrupted passage for fish when constructing major structures such as the Dirma siphon and ford (see Measure C5.3).	-	-	-
			C11.4 Develop and implement SOPs for working in and near watercourses including for traffic crossing watercourses (see Measures C5.3, C2.7).	-	-	-
			C11.5 Train staff in SOPs and emergency procedures (see Measure C5.5).	-	-	-
		Introduction of invasive species	C11.6 Clean all construction equipment and vehicles outside Lake Tana sub-basin, inspect on arrival at site, if not clean wash in safe location (see 5.3.3.2).	Full contract duration	Construction contractor / PSP contractor / BoEPLAU / BoARD	Contractor's overhead
Impacts on Wildlife	C12	Disturbance and exploitation during	C12.1 Use blasting blankets.	Full contract duration	Construction contractor	Nil - standard best practice

Project Activity or Topic	No.	Potential Impacts	Recommended Mitigation Measures, Construction	Timing	Institutional Responsibilities	Estimated Cost (USD '000)
Construction Phase						
		construction	C12.2 Use directional lights at night for camp and site illumination to minimise glare and night-bird disorientation.	Full contract duration	Construction contractor	Nil - contractor's overhead
			C12.3 Identify and demarcate sensitive habitats (wetlands) and ban construction force entry to these areas (see Measure C10.3).	-	-	-
			C12.4 Implement ban on purchase of wildlife products by construction staff and workers.	Full contract duration	Construction contractor / PSP contractor	Nil - standard best practice
Socio-economy						
Cultural Heritage	C13	Impacts on known and unknown physical cultural heritage	C13.1 Commission heritage survey by ARCCH, including implementation of any resulting recommendations (see Annex 12 for survey proposal by ARCCH).	Construction start-up	PSP contractor / ARCCH	20
			C13.2 Attach archaeologist to supervision team during earthworks at sensitive sites.	Full contract duration	PSP contractor / BoCTPD	12
			C13.3 Train equipment operators in artefact recognition.	Beginning of construction	Construction contractor / PSP contractor / BoCTPD / ARCCH	1
			C13.4 Ensure no project activities take place at sensitive locations including at least Narna, Kurtiye, Chehaldibi, Abba Taje and Choa Terrara hills.	Full contract duration	Construction contractor / PSP contractor	Management overhead
			C13.5 Obtain heritage clearance before all access road, borrow pit and quarry development.	Full contract duration	Construction contractor / PSP contractor / BoCTPD	Management overhead
			C13.6 Keep religious authorities informed of activities (see Measure CO23.2).	-	-	-

Project Activity or Topic	No.	Potential Impacts	Recommended Mitigation Measures, Construction	Timing	Institutional Responsibilities	Estimated Cost (USD '000)
Construction Phase						
Rapid Change	C14	Social dislocation and social resistance	C14.1 Continue intensive social preparation especially WUA formation and support (see also Measures PC18.1 and CO23.2).	Full contract duration	MoWE / BoWRD / Woreda / PSP contractor / ENIDP Component 3	50/yr
			C14.2 Implement land redistribution and consolidation in advance of physical construction (see also Impact C16 and associated measures).	Construction start-up at latest	Woreda / Kebeles / BoEPLAU / PSP contractor	See RAP
Land Loss	C15	Permanent loss of agricultural land and other assets	C15.1 Implementation of comprehensive, gender-sensitive RAP procedures (see Measures PC15.1, PC15.2, PC15.3, C16.1).	-	-	-
Land Redistribution	C16	Disruption of livelihoods due to reallocation and consolidation of land	C16.1 Implementation of comprehensive, gender-sensitive land reallocation and consolidation procedures (see Measures PC16.1, PC16.2, PC16.3, PC16.4).	-	-	-
Village Irrigation	C17	Disruption of settlements and associated impacts and health hazards	C17.1 Revise project concept to avoid irrigation development within settlement areas (see Measure PC17.1).	-	-	-
Disruption of Existing Agriculture	C18	Disruption of crop and livestock production by construction activities	C18.1 Phase project commissioning to allow lessons to be learned and capacity to develop (see also Measures PC18.1, PC18.2, PC18.3).	Project years 2 to 5	MoWE / BoWRD / BoARD / PSP contractor	Management overhead
Disruption of Access	C19	Disruption of access by new channels	C19.1 Construct additional pedestrian and livestock crossings in accordance with kebele requests.	Full contract duration	Construction contractor / PSP contractor / Kebeles	25
Employment	C20	Employment of outsiders	C20.1 Implement preferential hiring policy for labour (see also Measures PC20.1, PC20.2).	Full contract duration	Construction contractor / PSP contractor	Management overhead
To mitigate Impacts during Operation						
Agricultural Feasibility	O1	Potential delay in irrigated agriculture	CO1.1 Continuation of full-scale farm trial as necessary (see also Measure PO1.1).	Construction start-up	ARARI / BoARD	25

Project Activity or Topic	No.	Potential Impacts	Recommended Mitigation Measures, Construction	Timing	Institutional Responsibilities	Estimated Cost (USD '000)
Construction Phase						
		development	CO1.2 Continue implementation of ENIDP Component 2 activities.	Construction	ARARI / BoARD / MoWE / ENIDP Component 2	see PAD
Agricultural Sustainability	O2	Delayed uptake of benefits due to inability to meet on-farm skills, labour & equipment requirements	CO2.1 Carry out precise land levelling as a project capital investment.	Construction, prior to tertiary channel and on-farm channel construction	MoWE / Construction contractor	3,232
			CO2.2 Provide technical support to WUAs concerning on-farm (quaternary) irrigation and drainage channel design and construction.	Construction	PSP contractor	Management overhead
			CO2.3 Provide technical support to WUAs and farmers concerning in-field ridging and irrigation methods.	Construction and initial operation	PSP contractor	Management overhead
			CO2.4 Provide safe domestic water supplies to reduce labour demands on women, plus health benefits (see Measure CO34.1).	-	-	-
Erosion	O8	Erosion in command area	CO8.1 Re-vegetate all soil surfaces exposed during construction.	Full contract duration	Construction contractor	Contractor's overhead
Pests & Diseases	O12	Changes in pests and diseases	CO12.1 Targetted research on key crop pests and diseases and development of appropriate crop protection extension packages.	During both construction and operation	ARARI / BoARD / ENIDP Component 2	24/yr
Pesticides	O13	Inadequate pest management and improper use of pesticides	CO13.1 Prepare Phase 2 PMP including list of products approved for use on the project (as a last resort), build IPM into the project concept, and develop a coordination mechanism for all aspects of crop protection extension (see Annex 12 for outline ToR for development of Phase 2 PMP).	Construction	PSP contractor / ENIDP Component 2	33
			CO13.2 Develop specific IPM measures for the individual crops and crop sequences planned for MPIDP (see Measure CO12.1).	-	-	-

Project Activity or Topic	No.	Potential Impacts	Recommended Mitigation Measures, Construction	Timing	Institutional Responsibilities	Estimated Cost (USD '000)
Construction Phase						
			CO13.3 Develop similar targetted measures for integrated vector management (IVM).	Construction	ARARI / ENIDP Component 2	12/yr
			CO13.4 Design strategy and programme for protection and development of beekeeping.	Construction	BoARD / ARARI / Holetta Bee Research Centre	10
Ecology	O14	Habitat degradation	CO14.1 Review final designs to ensure that hydraulic connectivity is maintained between Dirma River, tributaries and wetlands, and ensure that construction matches approved designs (see also PO14.1).	Construction start-up, construction	PSP contractor	Management overhead
Fish	O20	Changes in river flows and morphology	CO20.1 Review detailed designs of main canal service road and drainage crossings / siphons at major tributaries and Dirma ford prior to construction to ensure compliance with best practice fish passage guidelines (see Annex 12 for outline ToR for this task).	Construction start-up	PSP contractor / BoARD / BFALRC	16
			CO20.2 Undertake comprehensive study of fish fauna of the major Dembia Plain rivers (Dirma, Nededit, Megech) and the associated wetlands focusing on wet season fish behaviour and habitat requirements, especially for migration of *Labeobarbus* species.	Construction	MoWE / MoARD / BoARD / BFALRC / BoEPLAU	20
Social Change	O23	Cultural constraints on social and economic change	CO23.1 Implement mass gender-sensitive adult literacy and numeracy campaign (see also Measure O23.1 and Impact O39).	Construction & operation	Woreda / BoE	60
			CO23.2 Establish and maintain links with Church elders concerning project activities and requirements	During both construction & operation	PSP contractor / Construction contractor / Woreda / Kebeles	Management overhead
			CO23.3 Support the formation and operation of local groups and associations to offset social dislocation, in addition to WUAs (see also Measure C14.1).	During both construction & operation	PSP contractor / Woreda	24/yr
Gender	O24	Impacts on women	CO24.1 Careful access and safety planning if settlements are developed for irrigation.	Construction	MoWE	Management overhead

Project Activity or Topic	No.	Potential Impacts	Recommended Mitigation Measures, Construction	Timing	Institutional Responsibilities	Estimated Cost (USD '000)
Construction Phase						
			CO24.2 Enhance capacity of Woreda Women's, Children's and Youth Affairs Office, *or* enhance PSP contractor's social unit to carry out same functions.	Construction	MoWE / BoWCYA	12/yr
Livestock Husbandry	O25	Impacts of transformation of livestock husbandry system	CO25.1 Implement livestock programme designed under Measure PO25.1.	Construction, Operation	"The Project" / BoARD / ENIDP Component 2	TBD under Measure PO25.1
			CO25.2 Designate land along rivers between new flood-control bunds as communal pasture.	Construction	Woreda / Kebeles / BoEPLAU	Management overhead
			CO25.3 Support kebeles in designating and demarcating livestock corridors between the new fields.	Construction	PSP contractor	Management overhead
			CO25.4 Construct watering points for livestock in consultation with Kebele staff and residents	Construction	Construction contractor / PSP contractor / Kebeles	10
Access	O27	Changes in local access, barrier effects, limited external links due to inadequate road maintenance	CO27.1 Build all roads to all-weather standard including community link roads (see also Measure PO27.1).	Construction	MoWE / Construction contractor	45
			CO27.2 Upgrade the Kola Diba - Guramba track to provide all-weather access to the command area (see also Measure PO27.2).	Construction	MoWE / Amhara Rural Roads Authority (ARRA) / Construction contractor	300
			CO27.3 Construct additional pedestrian and livestock crossings as needs become apparent (see Measure C19.1).	-	-	-
Health	O30	Extended malaria season	CO30.1 Bednet programme: distribution of LLINs, education and training, and monitoring.	Construction onwards	BoH / WorHO	TBD under Measure PO33.1
			CO30.2 Malaria diagnosis, treatment and management skills upgrading for front-line health workers.	Construction onwards	BoH / WorHO	TBD under Measure PO33.1

Project Activity or Topic	No.	Potential Impacts	Recommended Mitigation Measures, Construction	Timing	Institutional Responsibilities	Estimated Cost (USD '000)
Construction Phase						
	O31	Increased schistosomiasis	CO31.1 Repeated mass treatment of local population against schistosomiasis.	Construction onwards	BoH / WorHO	12.5 / yr
	O32	Changes in other diseases	CO32.1 Repeated mass treatment of local population against helminths (in combination with CO31.1).	-	-	-
			CO32.2 Intensified health education for population.	Construction onwards	BoH / WorHO	TBD under Measure PO33.1
			CO32.3 Provision of safe domestic water supplies close to houses (see Measure CO34.1).	-	-	-
			CO32.4 Health worker skills upgrading concerning ARTI diagnosis and treatment.	Construction onwards	BoH / WorHO	TBD under Measure PO33.1
			CO32.5 Improve availability and quality of drugs at local level and at affordable prices.	Construction onwards	BoH / WorHO	TBD under Measure PO33.1
			CO32.6 Improve physical access to health facilities for patients and staff: roads, bridges (see Measures CO27.1, CO27.2, CO27.3).	-	-	-
			CO32.7 Health worker skills upgrading concerning STDs and AIDS.	Construction onwards	BoH / WorHO	TBD under Measure PO33.1
			CO32.8 Adult education, especially female literacy, to enable residents to absorb and understand health information (see Measure CO23.1).	-	-	-
			CO32.9 Include mandatory household health insurance premium in the WUA fee to cover at least (i) travel costs to emergency care, and (ii) emergency treatment (see also Measure O32.19).	Construction onwards	WUAs / PSC contractor	Nil to project
	O34	Inadequate water, sanitation & hygiene reducing project benefits	CO34.1 Implement comprehensive programme to provide safe water near and in all settlements (see Impact O34).	Construction	"The Project" / BoWRD	200
			CO34.2 Establish water quality laboratory in Kola Diba (or at PSP offices) with associated equipment including transport.	Construction	BoWRD / BoH / Woreda	25

Project Activity or Topic	No.	Potential Impacts	Recommended Mitigation Measures, Construction	Timing	Institutional Responsibilities	Estimated Cost (USD '000)
Construction Phase						
	O35	Safety hazards	CO35.1 Provide steps to canals at key locations, in consultation with local water users.	Construction	Construction contractor / PSP contractor / kebeles	10
On-farm Management	O36	Ineffective operation of WUAs	CO36.1 Continue accelerated WUA establishment and support so that leaders and members can participate effectively in all project activities (see Measure C14.1).	-	-	-
Off-farm Management	O37	Risks of experimental O&M model	CO37.1 Review planned location of PSP contractor's compound to maximise long-term efficiency.	Construction start-up	PSP contractor	Management overhead
Services & Inputs for Agriculture	O38	Reduced project benefits due to inadequate provision of essential agricultural services	CO38.1 Ensure coordinated planning and delivery of *all* required agricultural service and inputs including research, knowledge, credit, crop storage and processing, links to markets etc. through the centralised management mechanism identified by Measure PO38.1.	Construction and Operation	MoWE / BoARD / ARARI / ENIDP Components 2, 3 / Rural Capacity Building Project (RCBP)	Management overhead
Social Services & Infrastructure	O39	Reduced project benefits due to inadequate provision of essential social services	CO39.1 Implement the comprehensive plan for non-agricultural service and infrastructure delivery (safe water, health, education, etc.) developed under Measure PO39.1.	Construction and Operation	MoWE / BoARD / other line agencies / Woreda	TBD under Measure PO39.1
To mitigate Cumulative Effects						
Hydrology	CE5	Inadequate information for planning	CCE5.1 Continue implementation of TBIWRDP, prioritising the establishment of hydrological monitoring and information systems.	Construction	TBIWRDP	See TBIWRDP PAD

Source: Consultant

8.3.3 Operation Phase

The following Table 8-6 lists potential impacts likely to occur in the Operation Phase and the measures recommended to mitigate them. Many of these measures should be implemented earlier, during Pre-construction or Construction, and therefore duplicate the entries in Table 8-4 and Table 8-5. They are listed here for completeness and to match the impact analysis in Chapter 5.

During project operation, a large number of the recommended measures would be most effective if implemented by a centralised project authority. At present this does not exist and is not planned. Consequently in this table institutional responsibility is sometimes allocated to "The Project" pending clarification of project implementation modalities.

Recommendations for the tender documents for the Operation and Maintenance Contractor (the same private sector company as the Supervision Consultant) are given in Annex 10.1 (in practice, this refers to the Private Sector Participation (PSP) contractor under the Management Services Contract (MSC)).

Notes on Operation Phase costs:

- The estimated costs in this table are given as "Nil" or "Management overhead" where the measure can be carried out under existing contracts or is a normal task of the proponent. In reality there will be a small professional and/or managerial time element involved.
- As noted in the introduction to the Pre-construction Phase (Section 8.3.1), the costs of implementation of a number of recommended measures will need to be determined by further analysis, outside the scope of this ESIA. This refers to, specifically, O13.1: Phase 2 Pest Management Plan; O13.2: Protection and development of Beekeeping; O25.1: Livestock Husbandry; O25.4: Mechanisation; O30.1, O30.2, O32.4, O32.5, O32.7, O32.8, O32.11, O32.12: various health measures; O38.1: Agricultural Inputs and Services; and O39.1: Non-agricultural Services and Infrastructure.
- "Contingency" costs cannot be estimated at this time.
- Rounded figures of USD 2,000 and USD 20,000 are used to represent 1 national specialist-month and 1 international specialist-month, respectively.

Table 8-6: ESMP for MPIDP: Operation Phase

Project Activity or Topic	No.	Potential Impacts	Recommended Mitigation Measures, Operation	Timing	Institutional Responsibilities	Estimated Cost (USD '000)
Operation Phase						
Agricultural Feasibility						
Agricultural Feasibility	O1	Potential delay in irrigated agricultural development	O1.1 Full scale trial on site: see Measures PO1.1, CO1.1.	-	-	-
			O1.2 Continue implementation of ENIDP Component 2 activities.	Operation	ARARI / BoARD / MoWE	see ENIDP PAD
Agricultural Sustainability	O2	Delayed uptake of benefits due to inability to meet on-farm skills, labour & equipment requirements	O2.1 On-site training and demonstrations using participatory approaches such as FREGs and FFS.	Operation	BoARD / ENIDP Component 2	50/yr
			O2.2 Convert to stall-feeding of livestock (see Measure O25.1), introduce mechanisation to reduce labour demands & free-up labour (see Measure O25.4).	-	-	-
			O2.3 Provide improved / new agricultural equipment and tools through subsidised system.	Operation	"The Project"	50/yr
Soil & Water Management						
Soil & Water Management	O3	Water use inefficiency	O3.1 Trial the System of Rice Intensification (SRI) to determine its relevance, and apply as indicated by trial results.	First years of operation	BoARD / ARARI / GARI / ENIDP Component 2	25
			O3.2 Convert to alternative irrigation technologies as soon as economic and skills conditions permit, or if environmental monitoring indicates incipient salinisation.	During operation	MoWE / BoARD	Contingency
	O4	Inadequate drainage	O4.1 Use or convert to sprinkler or drip irrigation (see Measure O3.2).	-	-	-
			O4.2 Minimise water applications through training and non-surface irrigation technologies (see Measures O2.1, O3.2).	-	-	-
			O4.3 Prioritise drain maintenance by WUAs.	During operation	WUAs / PSP contractor	Management overhead

Project Activity or Topic	No.	Potential Impacts	Recommended Mitigation Measures, Operation	Timing	Institutional Responsibilities	Estimated Cost (USD '000)
Operation Phase						
			O4.4 Ensure O&M contractor meets high drainage performance standards.	During operation	MoWE / BoWRD	Management overhead
			O4.5 Implement watershed management measures upstream, especially on Dirma River and its tributaries (see Measure O8.3).	-	-	-
	O5	Groundwater rise and secondary salinisation	O5.1 Provide training to farmers and WUAs to minimise excess water applications (see Measure O2.1).	-	-	-
			O5.2 Base water fees on volume used not on area irrigated, if feasible.	During operation	WUAs / PSP contractor	Management overhead
			O5.3 Enforce adequate drain maintenance by WUAs (see Measure O4.3).	-	-	-
			O5.4 Convert to other irrigation technologies (see Measure O3.2).	-	-	-
			O5.5 For non-sodic salinisation, apply acidifying fertilisers, organic matter, and leach with surface water.	During operation	WUAs / PSP contractor	Contingency
	O6	Decline in soil fertility	O6.1 Research and develop crop-specific fertiliser recommendations and provide easy access to inorganic fertilisers (see Impact O38 and associated Measures).	-	-	-
			O6.2 Improve fuelwood supply to reduce use of manure for fuel (see Measure O26.1).	-	-	-
	O7	Impact of vertisols on structures	O7.1 Design all structures to resist soil movement and erosion (see Measure PO6.1).	-	-	-
Erosion	O8	Erosion in command area & sedimentation from upstream	O8.1 Maintain the vegetation on all the soil surfaces in the command area originally exposed and revegetated by the construction contractor (see Measure CO8.1).	During operation	PSP contractor / WUAs	Nil - standard best practice
			O8.2 Pilot and promote the use of vetiver grass for bank stabilisation and erosion control.	During operation	PSP contractor / BoARD / ARARI	20

Project Activity or Topic	No.	Potential Impacts	Recommended Mitigation Measures, Operation	Timing	Institutional Responsibilities	Estimated Cost (USD '000)
Operation Phase						
			O8.3 Consider extending successful watershed management measures to watersheds upstream, especially along the Dirma River and its right bank tributaries.	During operation	BoARD	Contingency
			O8.4 Ensure that main natural drainage channels are fully maintained (see Measure O4.4).	-	-	-
Hydrology & Water Quality						
Hydrology	O9	Continuing impacts from floods	O9.1 Improve upstream catchment conditions (see Measure O8.3).	-	-	-
			O9.2 Develop flood management and mitigation plans for adoption by WUAs.	During operation	PSP contractor / WUAs	20
	O10	Impacts of climate on hydrology	No measures recommended, except monitoring at basin scale (see Measure CCE5.1).	-	-	-
Water Quality	O11	Pollution from agrochemicals, salts, waste	O11.1 Conserve existing wetlands and restore lakeshore wetland as buffer zones between command area and lake (see Impacts O14 and O19 and associated measures).	-	-	-
			O11.2 Promote IPM (see Impact O13 and associated measures, and Measures PO13.3 and CO13.4).	-	-	-
			O11.3 Research and develop crop-specific fertiliser recommendations (see Measure O6.1).	-	-	-
			O11.4 Consider the strategic option of promoting organic agriculture (see Measure O13.3).	-	-	-
			O11.5 Identify and promote appropriate latrine technologies (see Measure O32.4).	-	-	-
			O11.6 Support kebeles concerning solid waste management by providing assistance to design appropriate measures (see Impact O39 and associated Measures).	Operation	PSC contractor	20

Project Activity or Topic	No.	Potential Impacts	Recommended Mitigation Measures, Operation	Timing	Institutional Responsibilities	Estimated Cost (USD '000)
Operation Phase						
			O11.7 Enforce drainage channel maintenance duties of WUA members (see Measure O4.4).	-	-	-
Pests & Diseases						
Pests & Diseases	O12	Changes in pests and diseases	O12.1 Continue targetted research on key crop pests and diseases and delivery of IPM crop protection extension packages (see also Measures PO12.1 and CO12.1).	Operation	BoARD / ARARI / ENIDP Component 2	24/yr
Pesticides	O13	Inadequate pest management and improper use of pesticides	O13.1 Implement the Phase 2 PMP developed under Measure CO13.1, including necessary policy reforms as well as targetted IPM research, IPM training and extension, integrated vector management (IVM) in relation to livestock health, and control of the sale and use of non-approved products.	Operation	BoARD / ARARI / ENIDP Component 2	TBD by Measure CO13.1
			O13.2 Implement strategy for protection and development of beekeeping developed under Measure CO13.4.	Operation	BoARD / ARARI / ENIDP Component 2	TBD by Measure CO13.4
			O13.3 Consider the strategic option of promoting organic agriculture.	During operation	MoARD / BoARD / "The Project"	20
Ecology						
Ecology	O14	Habitat degradation	O14.1 Manage the project so as to retain habitat diversity, most importantly by ensuring the continued connectivity of rivers, tributaries and wetlands (see Measure CO14.1) and protecting the riparian wetlands.	During operation	PSP contractor / WUAs / Kebeles	Nil - standard best practice
			O14.2 Investigate enhancing profiles of main drainage channels for spawning of catfish and tilapia, and scale up if feasible.	During operation	PSP contractor / BoARD / BFALRC	10
			O14.3 Restore and manage the lakeshore wetland as buffer zone between lake and irrigation area (see Measure O19.1).	-	-	-
	O15	Ongoing impacts on globally important birds	O15.1 Manage the project to maintain wetland ecosystem functioning (see Impact O14 and associated measures).	-	-	-

Project Activity or Topic	No.	Potential Impacts	Recommended Mitigation Measures, Operation	Timing	Institutional Responsibilities	Estimated Cost (USD '000)
Operation Phase						
			O15.2 Restore and manage the lakeshore wetland zone (see Measure O19.1).	-	-	-
			O15.3 Information, education and awareness programme concerning birds and other wildlife, especially for children.	During operation	BoEPLAU / BoE	2/yr
			O15.4 Join Ramsar Convention, declare Lake Tana IBAs as Ramsar Site, manage lake and surrounding wetlands accordingly.	During operation	GoE: EPA	GoE overhead
	O16	Impacts on other wildlife	O16.1 Manage the project to maintain wetland ecosystem functioning (see Measure O14.1).	-	-	-
			O16.2 Restore and manage the lakeshore wetland zone (see Measure O19.1).	-	-	-
			O16.3 Awareness and education programme concerning wildlife, especially for children (see Measure O15.3).	-	-	-
	O17	Introduction of invasive species	O17.1 Ensure all fisheries professionals and technicians are aware of a strict ban on importing non-native fish to the Lake Tana basin.	During operation	BoARD / BoEPLAU / BFALRC	Management overhead
			O17.2 Ensure that all equipment brought to site for command area O&M is biosafe (see also Measure C11.6).	During operation	PSP contractor / BoEPLAU / BoARD	Nil - standard best practice
	O18	Reduced agrobiodiversity	O18.1 Contribute to regional agrobiodiversity survey programme.	During operation	IBC / BoARD / ARARI / universities / ENIDP Component 2	24 / yr
			O18.2 Use proven, well adapted varieties of seeds.	During operation	BoARD / ARARI / ENIDP Component 2	Nil - standard best practice
	O19	Increased stress on lakeshore zone	O19.1 Develop and implement a participatory lakeshore restoration programme in Seraba Dabelo and Achera Mariam kebeles (see Annex 12 for outline scope of pilot project).	During operation	BoEPLAU / Dembia Woreda / Seraba Dabelo & Achera Mariam Kebeles	173 (over 4 yrs)

Project Activity or Topic	No.	Potential Impacts	Recommended Mitigation Measures, Operation	Timing	Institutional Responsibilities	Estimated Cost (USD '000)
Operation Phase						
Fish	O20	Changes in river flows and morphology	O20.1 Implement local fisheries management programme using participatory methods in line with the findings of the wet season fish survey (see Measure CO20.2) and ongoing monitoring of fish migrations (see 8.5), integrated with the establishment of Kebele Fish Management Units under regional initiatives (see 5.4.7.1).	Construction and operation	MoARD / BoARD / EPLAUB / Woreda / BFALRC / FPME	25/yr
			O20.2 Consider implementation of canal aquaculture trial (see Annex 12 for outline scope of work for aquaculture trial).	During operation	MoARD / BoARD / BFALRC	156 (over 2 yrs)
			O20.3 Consider contributing to establishment of regional hatchery.	During operation	MoWE	50
	O21	Fish entrainment at pumping station	O21.1 Offset potential entrainment losses by better fish management elsewhere (see Impact O20 and associated measures).	-	-	-
			O21.2 Design and implement fish entrainment study (possible thesis) with Bahir Dar University and BFALRC.	During operation	PSP contractor / BoARD / BoEPLAU / BDU / BFALRC	5
	O22	Impact of water pollution	O22.1 Implement comprehensive IPM approach (see Impact O13 and associated measures).	-	-	-
			O22.2 Maintain all existing wetlands and restore those that have been degraded, to act as buffers between the PCA and Lake Tana (see Impacts O14 and O19 and associated measures).	-	-	-
Socio-economy						
Social Change	O23	Cultural constraints on social and economic change	O23.1 Complete mass gender-sensitive adult literacy and numeracy campaign (see also Measure CO23.1 and Impact O39).	During construction & operation	BoE / Woreda	20 (over 2 years)
			O23.2 Upgrade local education system to enable education to higher grades (see Measure O39.1).	-	-	-
			O23.3 Command area electrification (see Measure O26.4).	-	-	-

Project Activity or Topic	No.	Potential Impacts	Recommended Mitigation Measures, Operation	Timing	Institutional Responsibilities	Estimated Cost (USD '000)
Operation Phase						
			O23.4 Maintain all-weather road access (see Measure O27.3).	-	-	-
			O23.5 Maintain links with Church elders concerning project activities and requirements (see also Measure CO23.2).	Operation	PSP contractor / Woreda / Kebeles	Management overhead
			O23.6 Continue to support group formation and operation to offset social dislocation caused by rapid change (see also Measure CO23.3).	Operation	PSP contractor / Woreda	24/yr
Gender	O24	Impacts on women	O24.1 Provide safe domestic water supplies near houses (see Measure CO34.1).	-	-	-
			O24.2 Promote woodlots and tree planting to provide better access to fuel (see Measure O26.1).	-	-	-
			O24.3 Command area electrification (see Measure O26.4).	-	-	-
			O24.4 Careful access and safety planning if settlements are developed for irrigation (see Measure CO24.1)	-	-	-
			O24.5 Upgrade local health services (see Measure O33.1).	-	-	-
			O24.6 Ensure that women are fully represented in WUAs by establishing and maintaining mechanisms to ensure this (see Measure PO24.2).	-	-	-
			O24.7 Enhance the capacity of the Woreda Women's Affairs Office, especially to support vulnerable and abused women (see Measure CO24.2).	-	-	12/yr
			O24.8 Establish microcredit and income generation programmes especially for women.	During operation	"The Project" / PSP contractor	20/yr
			O24.9 Implement a major programme of adult literacy for women (see Measure O23.1).	-	-	-

Project Activity or Topic	No.	Potential Impacts	Recommended Mitigation Measures, Operation	Timing	Institutional Responsibilities	Estimated Cost (USD '000)
Operation Phase						
Livestock Husbandry	O25	Impacts of transformation of livestock husbandry system	O25.1 Continue implementation of the livestock programme as a major project component (see also Measures PO25.1 and CO25.1).	During operation	"The Project" / BoARD / ENIDP Component 2	TBD by Measure PO25.1
			O25.2 Use land along rivers between new flood dykes as pasture (see Measure CO25.2).	-	-	-
			O25.3 Establish livestock corridors between fields (see Measure CO25.3).	-	-	-
			O25.4 Implement the mechanisation policy and programme (see also Measure PO25.3).	During operation	"The Project" / BoARD / ENIDP Component 2	TBD by Measure PO25.3
Energy	O26	Inadequate fuelwood and energy	O26.1 Implement the programme to promote fuelwood plantations around villages developed under Measure PO26.1.	During operation	"The Project" / BoARD	20/yr (over 4 yrs)
			O26.2 Promote the use of low-smoke / fuel-efficient stoves (see also Measure O32.6).	During operation	"The Project"	10/yr
			O26.3 Install solar lighting in (initially) Achera Mariam and Seraba Dabelo kebele headquarters, including solar recharge points for mobile phones (as microenterprises), and roll out programme to households.	During operation	"The Project" / Rural Electrification Fund (REF)	50
			O26.4 Work with EEPCo, the Rural Electrification Fund and the woreda administration to develop firm plans for full electrification.	During operation	"The Project" / EEPCo / REF	Management overhead
Access	O27	Changes in local access, barrier effects, limited external links due to inadequate road maintenance	O27.1 Designate all projects roads as all-weather, and design and build them to this standard (see Measures PO27.1 and CO27.1)	-	-	-
			O27.2 Include upgrading of Kola Diba to Guramba track in construction package (see Measures PO27.2 and CO27.2).	-	-	-
			O27.3 Maintenance of all command area access roads as far as Kola Diba - Gorgora road (see also Measure PO27.3).	Operation	PSP contractor	See PSP contract

Project Activity or Topic	No.	Potential Impacts	Recommended Mitigation Measures, Operation	Timing	Institutional Responsibilities	Estimated Cost (USD '000)
Operation Phase						
			O27.4 Construct additional channel crossings as needed (see Measure C19.1).	-	-	-
			O27.5 Consider upgrading the east-west road links in the Dembia Plain, with road crossings of old and new Megech Rivers.	Operation	ERA / Amhara Rural Roads Authority (ARRA)	Contingency
Benefits & Equity	O28	Inequitable distribution of benefits - incomes and employment	O28.1 Pay special attention to women during the land redistribution process (see Measures PC16.2).	-	-	-
			O28.2 Establish special programmes for women during project operation (see Impact O24 and associated measures).	-	-	-
			O28.3 Pay special attention to the protection of fish habitat and the avoidance of water pollution so as to reduce impacts on fish-dependent households (see Impacts O20 and O22 and associated measures).	-	-	-
			O28.4 Pay special attention to safe pest management to minimise health impacts (see Impact O13 and associated measures).	-	-	-
			O28.5 Pay special attention to the development of farm to market links for niche and export crops that do not compete with other local producers (see Measure O29.1).	-	-	-
	O29	Price reductions in local markets and associated impacts on rain-fed producers	O29.1 Manage scheme to focus on import substitution and export crops.	Operation	"The Project" / ENIDP Component 2	Management overhead
Health	O30	Extended malaria season	O30.1 Bednet programme including LLIN distribution, education and training, and monitoring (see also Measure CO30.1).	Construction onwards	BoH / WorHO	TBD under Measure PO33.1
			O30.2 Malaria diagnosis, treatment and management skills upgrading for front-line health workers (see also Measure CO30.2).	Construction onwards	BoH / WorHO	TBD under Measure PO33.1

Project Activity or Topic	No.	Potential Impacts	Recommended Mitigation Measures, Operation	Timing	Institutional Responsibilities	Estimated Cost (USD '000)
Operation Phase						
	O31	Increased schistosomiasis	O31.1 Repeated mass treatment of local population against schistosomiasis (see also Measure CO31.1).	Construction onwards	BoH / WorHO	12.5 / yr
	O32	Changes in other diseases	O32.1 Repeated mass treatment of local population against helminths (in combination with O31.1; see also Measure CO32.1).	-	-	-
			O32.2 Intensified health education for population (see also Measure CO32.2).	Construction onwards	BoH / WorHO	10 / yr
			O32.3 Provision of safe domestic water supplies close to houses (see Measure CO34.1).	-	-	-
			O32.4 Trials to identify culturally acceptable and affordable latrine technologies, and scaling up if successful.	During operation	BoH / WorHO	TBD under Measure PO33.1
			O32.5 Extension of SAFE programme against trachoma.	During operation	BoH / WorHO	TBD under Measure PO33.1
			O32.6 Promotion of technologies to reduce indoor smoke: ventilation, smokeless stoves, solar cookers etc. (see Measure O26.2).	-	-	-
			O32.7 Health worker skills upgrading concerning ARTI diagnosis and treatment (see also Measure CO32.4).	Construction onwards	BoH / WorHO	TBD under Measure PO33.1
			O32.8 Improve availability and quality of drugs at local level and at affordable prices (see also Measure CO32.5).	Construction onwards	BoH / WorHO	TBD under Measure PO33.1
			O32.9 Improve physical access to health facilities for patients and staff (see Measures O27.1, O27.2, O27.3).	-	-	-
			O32.10 Promote wise use of increased incomes.	During operation	PSP contractor / WUAs	5/yr
			O32.11 Implement STD & HIV/AIDS information, education and awareness campaign, focusing on market centres.	During operation	BoH / WorHO	TBD under Measure PO33.1

Project Activity or Topic	No.	Potential Impacts	Recommended Mitigation Measures, Operation	Timing	Institutional Responsibilities	Estimated Cost (USD '000)
Operation Phase						
			O32.12 Health worker skills upgrading concerning STDs and AIDS (see also Measure CO32.7).	Construction onwards	BoH / WorHO	TBD under Measure PO33.1
			O32.13 Provide resources to sensitise decision-makers concerning the importance of HIV/AIDS and its reduction if managed appropriately.	During operation	BoH / WorHO	2/yr
			O32.14 Adult education, especially female literacy, to enable residents to absorb and understand health information (see Measures CO23.1 and O23.1).	-	-	-
			O32.15 Integrate nutrition into health awareness and education programme, focusing on nutritional gender issues and children.	During operation	BoH / BoE	2/yr
			O32.16 Promote homestead gardens and livestock micro-enterprises to enrich household food supplies.	During operation	"The Project"	25/yr
			O32.17 Train all farm workers in safe use of new tools and equipment (see Measure O35.2).	-	-	-
			O32.18 Provide awareness training to population concerning dangers of traffic, equipment, water and chemicals (see also Measure O35.1).	During operation	"The Project" / National Road Safety Coordination Office (NRSCO) / ENIDP Component 2	5/yr
			O32.19 Include a mandatory household health insurance premium in the WUA fee to cover at least (i) travel costs to emergency care, and (ii) emergency treatment (see also Measure CO32.9)	Construction onwards	PSP contractor / WUAs	Nil to project
	O33	Impact of continuing poor health on beneficiaries' ability to benefit from project	O33.1 Long-term investment in social services (education, health) with special attention to women's issues (see Impacts O24 & O39 and associated measures).	-	-	-
			O33.2 Improve roads, electricity, housing, sanitation and (most important) safe domestic water supplies (see Impacts O26, O27, O32, O34 and associated measures).	-	-	-

Project Activity or Topic	No.	Potential Impacts	Recommended Mitigation Measures, Operation	Timing	Institutional Responsibilities	Estimated Cost (USD '000)
Operation Phase						
			O33.3 Improve incomes (project objective).	-	-	-
	O34	Inadequate water, sanitation and hygiene reducing project benefits	O34.1 Maintain the safe water supplies near and in all settlements constructed under Measure CO34.1, including the water quality lab and associated testing programme established under Measure CO34.2.	Operation	BoWRD / Woreda	10/yr
			O34.2 In longer term, initiate programme of rainwater harvesting using metal roofs and low-cost storage tanks.	During operation	"The Project"	Contingency
			O34.3 Identify and promote appropriate latrine systems (see Measure O32.4).	-	-	-
	O35	Safety hazards	O35.1 Traffic safety awareness campaign in local schools (see Measure O35.1).	-	-	-
			O35.2 Train all farm workers in safe use of tools and equipment.	During operation	"The Project" / PSP contractor	5/yr
			O35.3 Provide steps to canals at key locations (see Measure CO35.1).	-	-	-
			O35.4 Design Dirma River siphon trash rack to exclude children and minimise risk of being trapped against the bars (see Measure PO35.1).	-	-	-
			O35.5 Avoid construction of water-filled channels through settlements (see Measure PC17.1).	-	-	-
Institutional						
On-farm Management	O36	Ineffective operation of WUAs	O36.1 Provide PSP contractor with adequate resources for an effective, intensive WUA support programme (see Measure PO36.1).	-	-	-
			O36.2 Accelerate WUA establishment so that leaders and members can be involved in system planning and construction (see Measures PO36.2 & CO36.1).	-	-	-
Off-farm Management	O37	Risks of experimental O&M model	O37.1 Ensure that O&M contractor's contract provides sufficient incentives and legal clarity for effective performance (see Measure PO37.1).	-	-	-

Project Activity or Topic	No.	Potential Impacts	Recommended Mitigation Measures, Operation	Timing	Institutional Responsibilities	Estimated Cost (USD '000)
Operation Phase						
			O37.2 Review planned location of PSP contractor's compound to maximise long-term efficiency (see Measure CO37.1).	-	-	-
Services and Inputs for Agriculture	O38	Reduced project benefits due to ineffective provision of essential agricultural services & inputs	O38.1 Continue implementation and delivery of integrated programme of agricultural services and inputs (see also Measures PO38.1, PO38.2 & CO38.1).	Operation	"The Project" / PSP contractor	TBD under Measure PO38.1
Social Services & Infrastructure	O39	Reduced project benefits due tot ineffective provision of essential social services, especially health, water and sanitation, literacy	O39.1 Continue to implement the comprehensive plan for non-agricultural service and infrastructure delivery (safe water, health, education, etc.) developed under Measure PO39.1).	Operation	MoWE / BoARD / other line agencies / Woreda	TBD under Measure PO39.1
Economic						
Markets	O40	Market inelasticity affecting economics of entire project	O40.1 Continue to develop and implement action plans for adding value to command area produce and accessing markets.	During operation	"The Project" / ENIDP Component 2	See ENIDP Component 2
O&M Costs	O41	Unaffordable O&M costs	O41.1 Write off the project's capital costs (it is understood this will be done).	-	MoWE	GoE overhead (~21,700)
			O41.2 Phase in O&M fees gradually, in line with farmers' ability to pay.	During operation	MoWE / PSP contractor	Management overhead
Capital & Operating Costs of Scheme	O42	Under-funding of costs of compensation and resettlement, agricultural research, extension services & farmer training, equipment, environmental & social mitigation and monitoring, etc.	O42.1 Review overall project concept and plan to ensure that (i) all measures necessary for sustainable success have been identified and designed, and (ii) that these measures are fully funded (both capital and operating costs) (see Measure PO42.1).	-	-	-

Project Activity or Topic	No.	Potential Impacts	Recommended Mitigation Measures, Operation	Timing	Institutional Responsibilities	Estimated Cost (USD '000)
Operation Phase						
To mitigate Cumulative Effects						
Hydrology	CE1	Insufficient water	CE1.1 Develop an integrated water resources management (IWRM) plan for the Lake Tana basin based on actual hydrology.	During operation	MoWE / ABA	250
	CE2	Conflicts between users	CE2.1 Include a multi-stakeholder rule-making mechanism in the IWRM plan (see above).	During operation	MoWE / ABA	Management overhead
	CE3	No environmental flows	CE3.1 Determine environmental flows for Blue Nile using multi-stakeholder process.	During operation	MoWE / ABA	50
	CE4	Reduced flows at border	CE4.1 Regulate (augment) dry season flows using water from future storage dams on Blue Nile in Ethiopia.	To be determined	MoWE / ABA	Contingency
	CE5	Inadequate information for planning	CE5.1 Continue implementation of TBIWRDP, prioritising operation of the hydrological monitoring and information systems (see also Measure CCE5.1).	Construction & operation	TBIWRDP	50/yr
	CE6	Little understanding of system	CE6.1 Develop IWRM plan as a participatory process with a major information and awareness component (see Measures CE1.1, CE2.1).	-	-	-

Source: Consultant

8.4 ESMP SUB-PLANS AND MAJOR CONTRIBUTING REPORTS

8.4.1 Resettlement Action Plan

A Resettlement Action Pan (RAP) is being prepared for the project by another consultant. This will cover compulsory land acquisition and associated impacts including physical and economic displacement, land redistribution and consolidation, and support measures to protect the most vulnerable local residents affected by these changes.

Reference to the RAP in this ESMP are to the draft version (SMEC, Aug. 2010).

8.4.2 Phase 1 Pest Management Plan

A Phase 1 Pest Management Plan (PMP) forms part of this ESMP and is presented as a self-contained report at Annex 8.

The "Phase 1" refers to the World Bank's two-phased procedure for developing PMPs (described in BP 4.01 - Annex C): the first phase of the process - an initial reconnaissance to identify the main pest problems and their contexts (ecological, agricultural, public health, economic, and institutional) and to define broad parameters - is carried out as part of project preparation and is evaluated at appraisal. The second phase - development of specific operational plans to address the pest problems identified - is often carried out as a component of the project itself. Accordingly, an initial reconnaissance has been carried out involving (i) desktop review of available information, (ii) meetings with relevant national and regional institutions, (iii) meetings with key informants in the project area. The results are presented in the Phase 1 PMP which is intended to:

- Meet the requirements for a Phase 1 Pest Management Plan for the MPIDP in terms of Bank procedures for project preparation.
- Establish the basis for development of a Phase 2 Pest Management Plan early in project implementation. This appears in ESMP Table 8-5 as Measure CO13.1.

The PMP covers the Megech area but can easily be adjusted to include the Ribb project as well. Agronomic conditions in both command areas are similar (but not identical), as are the recommended mitigation measures.

The most important findings and recommendations of the PMP are included in this report, including in the ESMP tables.

Outline ToR for preparation of the Phase 2 PMP are attached at Annex 12.

8.4.3 Rapid Health Appraisal

A Rapid Health Appraisal was carried out to inform the ESIA analysis and is presented as a self-contained report at Annex 7.

The Appraisal covers both the Megech and Ribb projects (MPIDP and RIDP). Health conditions in both command areas are similar (but not identical), as are the recommended mitigation measures.

The most important findings and recommendations of the appraisal are included in this report, including in the ESMP tables.

The ANRS Bureau of Health (BoH) in Bahir Dar is aware of the health appraisal and is understood to be considering an appropriate institutional response. This appears in ESMP Table 8-4 as Measure PO33.1.

8.4.4 Reconnaissance Physical Cultural Heritage Survey

A Reconnaissance Physical Cultural Heritage Survey was carried out to inform the ESIA analysis and is presented as a self-contained report at Annex 9.

The Survey covers both the Megech and Ribb projects (MPIDP and RIDP). Heritage conditions in both command areas are similar (but not identical), as are the recommended mitigation measures.

The most important findings and recommendations of the survey are included in the main text of this report, including in the ESMP tables, as well as in Annex 9.

The survey has been discussed with the Authority for Research and Conservation of Cultural Heritage (ARCCH). As the responsible national agency, the ARCCH has proposed its own follow-up survey to confirm and extend the findings of the ESIA's reconnaissance survey, with further actions dependent on the findings of the official ARCCH survey. The ARCCH's proposal and budget is attached at Annex 12. It appears in ESMP Table 8-5 as Measure C13.1.

8.5 MONITORING

8.5.1 Compliance Monitoring

Environmental monitoring is often divided into two basic categories, compliance and effects. Compliance monitoring relates to whether the agreed environmental and social measures are being implemented on time and to adequate standards. Effects monitoring relates to the impacts of the project on the receiving social and physical environment, and *vice versa*: information on these subjects assists project management to change or improve how things are being done.

This section covers compliance monitoring, by project stage.

Pre-construction Monitoring

- The project proponent (MoWE) and financial sponsor (World Bank) should check that the pre-construction measures identified in this ESMP (Table 8-4 and Annex 10) have been acted on.
- There may be a role for the federal and/or regional environmental regulators (EPA, BoEPLAU) to independently cross-check implementation at this stage.
- Considering the scale of the project (together with the RIDP), the sensitivity of the receiving environment (social, physical and ecological), and the risks (see Chapter 9), it is suggested that a Panel of Experts could play an important role in providing independent oversight and advice at this stage.

Construction Phase Monitoring

- The environmental and social activities of the construction contractor will be checked by the supervision consultant ("the Engineer") on behalf of MoWE ("the Employer"). The supervision consultant will be a "Private Sector Participation" (PSP) contractor commissioned through an internationally-tendered Management Services Contract (MSC).
- If the construction contractor implements a certifiable EMS and/or social accountability system, as recommended in this ESMP (see Annex 10.2), then these will be audited regularly by qualified external auditors.
- With respect to the RAP, the ToR for the Management Services Contract include the Construction Phase task "Verify that land acquisition and any physical resettlement plans have been established, in accordance with the Resettlement Action Plan (RAP) ahead of relevant construction and that compensation or restoration for loss of assets or land has been made prior to construction start". This is an extremely important task since, in accordance with Bank policy, physical construction cannot be started until compensation has been paid and physical resettlement satisfactorily implemented.

  Note: since the MSC also includes the task " … to provide advisers, during the 3 year construction period, to assist in facilitating the land allocation process", it will be important to guard against a possible conflict of interest on the part of the PSP contractor.
- During construction the ANRS BoEPLAU will have a role, as regional environmental regulator, in periodically checking ESMP implementation (Table 8-5) on the basis of (i) progress reports sent by the project management unit, and (ii) independent inspections.
- Working groups set up to manage specific topics, such as health and IPM (see relevant recommendations in As a management *aide memoire,* a checklist of 7 key actions considered necessary in the Pre-Construction Phase is given in Table 9-1 (for details see the corresponding items in the ESMP, Chapter 8, and impact analysis, Chapter 5).
- Table 9-1) will oversee progress in these fields.
- The Bank will mount periodic supervision missions.
- It is considered that a Panel of Experts could play an important role at this stage.
- It is understood that an "Independent Expert" will have a role in oversight of the Management Services Contract, carrying out annual audits and reviews of project progress and the PSP contractor's performance.

Operation Phase Monitoring

- WUAs will be responsible for establishing and enforcing bylaws concerning subjects with important environmental effects such as drain maintenance, and for running their own affairs in accordance with appropriate standards of transparency and representativeness.
- The PSP contractor (the same company as the supervision consultant during construction) will support the WUAs but, as a private sector organisation, will not have any enforcement capability. This will be a matter for the concerned government departments, on the basis of information supplied by the PSP contractor.
- MoWE will monitor the performance of the PSP contractor through agreed performance indicators, established in the contract.
- The PSP contractor's performance will also be checked by external auditors in connection with any EMS or certifiable social accountability system which this organisation is implementing (as recommended in this ESMP: see Annex 10.1).
- ANRS BoEPLAU will have a role in checking ongoing implementation of the relevant ESMP measures (Table 8-6).
- As during construction, the Bank will mount periodic supervision missions.
- It is considered that a Panel of Experts could continue to play an important role at this stage.

8.5.2 Effects Monitoring

As noted above, environmental effects monitoring relates to checking the impacts which the project is having on the environment, to determine whether management action is necessary. This is done by regularly measuring *indicators* relevant to each topic. In World Bank terminology this is Environmental Performance Monitoring. Guidance is given in the relevant Environmental Assessment Update[106].

On this project effects monitoring should cover a large number of topics, corresponding to the project's widespread potential impacts and numerous activities (especially if all the measures recommended in this ESMP are implemented in practice). Most of these should be measured routinely as a matter of standard management (for example, weather characteristics to assist in irrigation scheduling, soil quality to assist in fertiliser recommendations, farmer group formation to enable extension and training).

- Physical monitoring should focus on parameters necessary to manage the difficult soil conditions, most importantly to provide information on groundwater rise and soil salinity. Specific parameters are noted in Table 8-7.
- Biological monitoring should focus on (i) use of the command area and adjacent wetlands by at-risk birds, and (ii) use of the rivers by migratory fish (Labeobarbus spp.).
- Social monitoring should focus on (i) incomes, (ii) health, and (iii) gender.

  Specific recommendations for health monitoring are given in the Rapid Health Appraisal (Annex 7).

The proposed monitoring framework is presented in Table 8-8.

Note: the ToR for the Management Services Contract include the following monitoring activities in the PSP Contractor's tasks:

Construction

- "Monitor implementation of Environmental and Social Management Plan of the Scheme during construction phase, including archaeological surveys."
- "Monitor implementation of the Health Safety Plan. Check and ensure that the Contractor has taken suitable measures with regard to the safety and health of its workers (e.g. provision of potable water, lodging, mosquito nets, and first aid kits), site safety, and accident prevention measures. Inspect the security and safety aspects of construction and temporary works to ensure that every reasonable measure has been taken to protect life and property."
- "Monitor implementation any public health requirements including HIV/AIDS awareness and prevention."

Operation

- "Establish and maintain a small network of climatic stations measuring at least rainfall and evapotranspiration ..."
- "Record tertiary levels and flows under a pre-agreed procedure to be developed with WUAs."

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106 World Bank. 1996. *Environmental Performance Monitoring and Supervision.* Environmental Assessment Sourcebook Update No. 14.

Table 8-7: MPIDP - Proposed Soil and Groundwater Monitoring

Topic	Parameter	Frequency	Location
Soil quality	pH EC_e Exchangeable sodium percentage (ESP) Sodium adsorption ratio (SAR) Organic matter Cation exchange capacity (CEC) Nitrates P, K, Ca status Micro-nutrients if indicated	Prior to main crops (i.e. at least twice per year)	Composite samples from mineral soil at 5-30 cm depth, each sample to represent ~16 ha
Groundwater depth	Depth to groundwater	Monthly	Fixed observation wells established on grid, each well representing ~100 ha
Groundwater quality	pH Salinity (EC) Nitrates Phosphorous Pesticide residues	Monthly Monthly 6 months 6 months if indicated by drainage or surface water tests	All observation wells All observation wells All observation wells All observation wells All observation wells
Drainage water quality	pH Salinity (EC) Pesticide residues Coliforms	Monthly Monthly Monthly Monthly	Outfalls to main drains Outfalls to main drains Outfalls to main drains Outfalls to main drains
Surface water quality - receiving waters	pH Salinity (EC) Nitrates Phosphorous Pesticide residues Coliforms BOD COD Nitrates Phosphorous	Monthly Monthly 6 months 6 months Monthly Monthly Monthly Monthly 6 months 6 months	Pumping station intake, Dirma, Nededit and Megech River mouths, in lake midway between Dirma and Megech (no river influence), Dirma and Nededit Rivers in and above command area
Responsibility:	PSP Contractor		
Cost elements:	Laboratory (building, equipment) Observation wells (~40) Vehicle (4WD twincab pickup) Technician (full-time) Operating costs (transport, consumables)		

Source: Consultant

- "Record water levels at tertiary drain outlets in rainy season (at an appropriate frequency or upon complaint from WUA) and check for inundation of field crops due to lack of drainage; record any damage to crop due to inundation."
- Monitor water management: a detailed list of Water Performance Indicators relating to reliability, adequacy, timeliness, continuity, efficiency, productivity and cost effectiveness is given in Annex 4 to the MSC ToR.
- "Monitoring outputs from irrigated agriculture in terms of crops, production, yields and income (gross margin) on the basis of a sample of farmers selected from various parts of the scheme ... "
- Monitor performance: a detailed list of Key Performance Indicators (KPIs) relating to staffing and labour, administration and finances, capacity building and customer services, operation and maintenance is given in Annex 4 to the MSC ToR.

8.5.3 Reporting Procedures

Construction: during construction the contractor will supply regular progress reports (probably weekly and monthly) to the Engineer (the supervision (PSP) consultant) covering all aspects of the Works. The progress reports will include data and information on health and safety (accidents and incidents), environmental protection (spill and non-compliance), labour (numbers, grades, problems), community relations (complaints, issues), and relevant training.

The supervision consultant (the PSP contractor) will check the contractor's reports and forward them to the Employer (MoWE), including any additional records concerning implementation of the project's RAP and ESMP.

It is important that the Employer's and PSP contractor's staff on Site establish and maintain effective communication links with Dembia Woreda administration to ensure easy two-way flow of information.

The ANRS BoEPLAU is responsible for implementation of the RAP. In addition, it is recommended that they be formally informed about progress in implementation of the ESMP. This could be done by providing BoEPLAU with the regular monthly records, with external audit reports (see below) or, for example, relevant sections of Aide Memoires (reports) from Bank supervision missions.

Operation: during project operation a large number of environmentally and socially related measures and programmes will be implemented, by different organisations. Reporting on these will be uncoordinated unless a single management organisation is established to manage and track all aspects of the project. In practical terms, this would be done most easily by the PSP contractor. The ToR for the MSC contract include a requirement to establish and operate a fully functional management information system covering all aspects of the project including its social and environmental performance.

Table 8-8: Monitoring Programme for MPIDP

Mitigation Measure	Monitoring Objective	Indicator / Parameter to be Monitored	Method	Location	Frequency	Responsibilities	Estimated Cost (USD '000)
Pre-Construction							
All pre-construction mitigation measures (P, PC, PO)	Have the measures been implemented?	Formal inclusion of measure in project plans and budgets	MoUs / Aide Memoires, tender design, construction contract, supervision ToR, supervision contract (MSC), budgets	Addis Ababa	Monthly	WB / MoWE / EPA	Management overhead
Construction							
All the construction contractor's HSE, labour welfare and social requirements	Compliance	Existence, quality, depending on measure	Visual inspection, reports	Site	Daily, weekly	Supervision consultant (PSP contractor)	120+72 (6 mo int. + 36 mo national HSE specialist*)
Wetland protection	To determine area and ecological functioning (quality) of wetlands	Area in good condition	Visual inspection and GPS mapping	Dirma River and lakeshore wetlands	6 monthly (before, after rainy season)	BoEPLAU	3 (0.5 each survey)
		Presence and numbers of birds	Bird counts, focusing on cranes	Dirma River and lakeshore wetlands	Annual (dry season)	BoEPLAU	6 (2 each survey)
Fish protection	To determine existence and size of fish migrations	Fish migrating upstream	Observation & netting	Dirma River and tributaries	Annual (start of spawning season: early rains)	BoARD / BoEPLAU / BFALRC	6 (2 each survey)
Social protection	To check on status of vulnerable households	As specified in RAP					
Health protection	(i) to determine the effectiveness of the mitigation measures, (ii) to obtain early warning of changes in health hazards	As recommended in Table 7 in Annex 7, Rapid Health Appraisal					
Operation							
All the PSP contractor's HSE, labour welfare and social requirements	Compliance	Existence, quality, depending on measure	Visual inspection, reports	Site	Monthly	MoWE / BoEPLAU / Independent Monitor	2/yr (1 month per year for HSE specialist*)

Mitigation Measure	Monitoring Objective	Indicator / Parameter to be Monitored	Method	Location	Frequency	Responsibilities	Estimated Cost (USD '000)
Soil & water protection	To obtain early warning of adverse changes	See previous table - Soil & Groundwater Monitoring				PSP Contractor	24/yr (Full-time technician*)
Wetland protection	To determine area and functioning (quality) of wetlands	Area in good condition	Visual inspection and GPS mapping	Dirma River and lakeshore wetlands	6 monthly (before, after rainy season)	BoEPLAU	1/yr (0.5 each survey)
		Presence and numbers of birds	Bird counts, focusing on cranes	Dirma River and lakeshore wetlands	Annual (dry season)	BoEPLAU	2/yr (2 each survey)
Fish protection	To determine existence and size of fish migrations	Fish migrating upstream	Observation & netting	Dirma River and tributaries	Annual (start of spawning season: early rains)	BoARD / BoEPLAU / BFALRC	2/yr (2 each survey)
	To check if flows are adequate for fish passage	Flow volume and depth	Gauge at control sections	Dirma River and tributaries, Nededit River, above and below command area	Ideally, continuous. Otherwise daily	PSP Contractor	2/yr
Social protection	To determine impacts on vulnerable groups & check status of vulnerable households	Continuation of monitoring defined in RAP, as appropriate					
		Economic status of at-risk households	Household surveys	Command area	6 monthly	"The Project" / RPCO	24/yr (Full-time social specialist*)
Health protection	(i) To determine the effectiveness of the mitigation measures, (ii) To obtain early warning of changes in health hazards	As recommended in Table 7 in Annex 7, Rapid Health Appraisal					

* Estimated person-month requirement; will require operational support, e.g. vehicle, field equipment.
Cost assumption: USD 2,000/mo for national specialist, inclusive.

Source: Consultant

8.5.4 Auditing

As recommended in Annex 10, the PSP Contractor and the Construction Contractor should, as part of their quality assurance and quality control (QA/QC) systems:

- Establish and implement an Environmental Management System (EMS) on Site. This could be based on either ISO 14001 or on the EU's EMAS (Eco-Management and Audit Scheme).
- Establish and implement social accountability or corporate social responsibility programmes or systems based on either the certifiable standard SA 8000 or the new ISO standard "Guidance on social responsibility" (ISO 26000).

If this is done, then both systems will require auditing by certified quality inspectors (note that the ISO standard on social responsibility is not certifiable). This will require short visits by certified quality inspectors, probably every 6 months (initially).

Auditing of ESMP implementation and/or effectiveness also requires external specialist skills. These could be provided by the Panel of Experts (if established) or by other highly experienced, independent specialists, for example by expanding the role of the Independent Expert understood to be involved in monitoring the performance of the PSP contractor.

8.6 Institutional Arrangements

8.6.1 Overall Arrangements

The project proponent, the Ministry of Water and Energy (MoWE) is carrying out a major development project within Amhara National Regional State (ANRS) using international financing. The Megech Pump (Seraba) project is part of a larger project covering some 20,000 ha, the Ethiopian Nile Irrigation and Drainage Project (ENIDP). A detailed description of each ENIDP component of the larger project is given in the Project Appraisal Document (PAD: World Bank 2007) and Project Implementation Manual (PIM: World Bank 2007).

The roles and responsibilities of different levels of government (federal, regional, zonal and woreda) for implementation of ENIDP are set out in the *Memorandum of Understanding among Implementing Agencies on Project Management and Implementation Modality* (ENIDP Amhara Region Project Coordination Office 2009: see Section 2.8.2 of this ESIA report).

The project's physical infrastructure will be built by a contraction contractor commissioned through an international tender process. During the four year construction and defects liability period the construction contractor will be supervised, on behalf of the MoWE, by a supervision consultant termed the "Private Sector Participation (PSP) contractor".

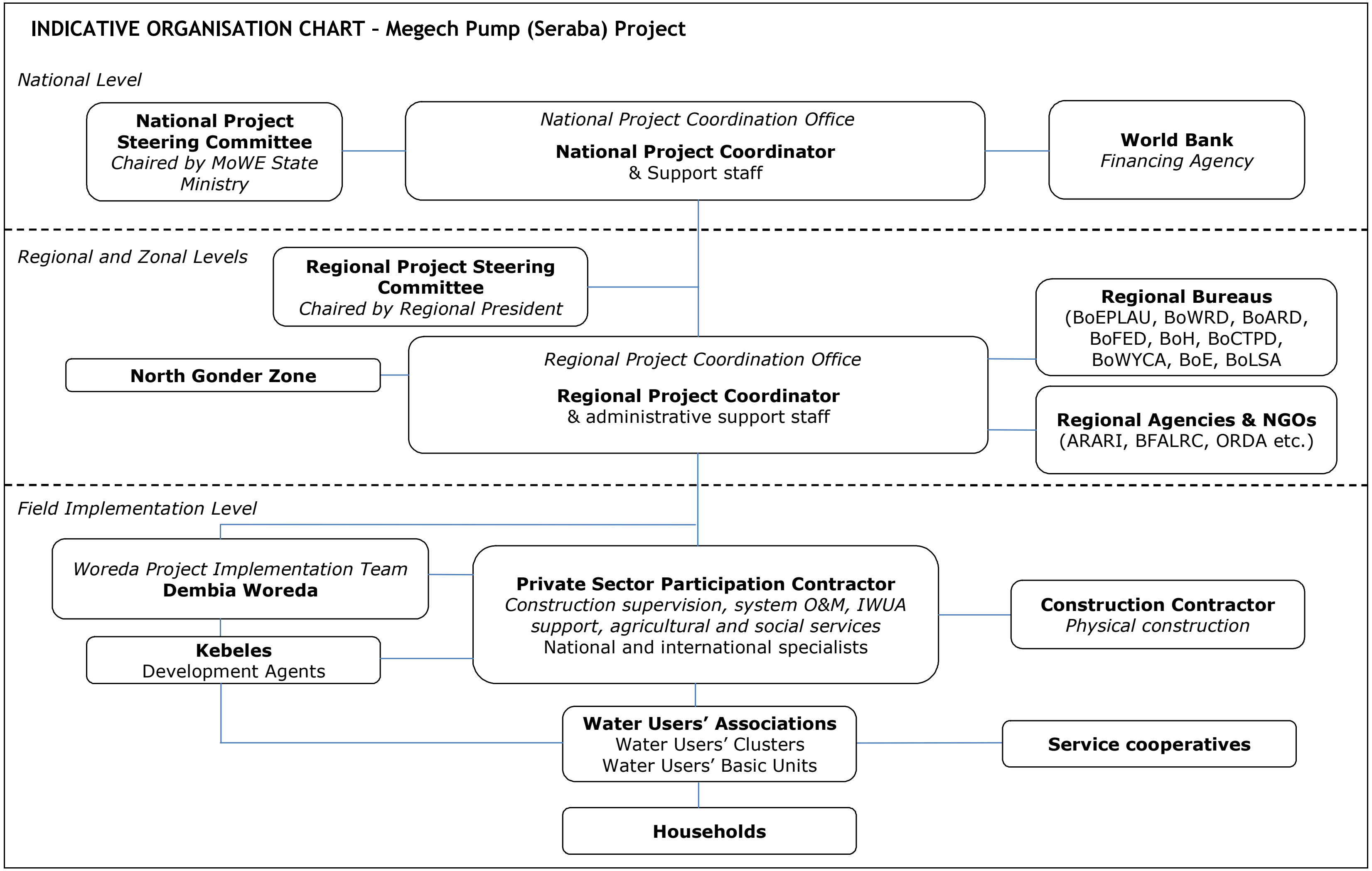
When the scheme has been commissioned (commencing in Project Year 3), the PSP contractor will take over off-farm operation and maintenance (O&M) until Project Year 8, again on behalf of the MoWE. On-farm O&M will be carried out by Irrigation Water Users' Associations (WUAs).

It is envisaged that at some future date the WUAs will have become sufficiently capable to take over responsibility for scheme O&M.

In addition to construction supervision and off-farm O&M, the PSP contractor will provide numerous other services including, for example, support for WUA formation and capacity building, water fee collection, and monitoring.

The overall structure of the project's implementation mechanisms is diagrammed in Figure 8-1. Notes on implementation mechanisms for specific topics are given below.

Figure 8-1: Project Organisation



Source: Consultant

8.6.2 Land Acquisition, Compensation, Resettlement and Land Redistribution

Responsibility for implementation of the land acquisition, compensation, resettlement, land reallocation and consolidation programme lies with the regional Bureau of Environmental Protection, Land Administration and Use (BoEPLAU) and its zonal and woreda level counterparts. Detailed procedures will be described in the Resettlement Action Plan (RAP).

The key interface between command area residents and BoEPLAU will be the new Irrigation Water Users' Associations (WUAs). Their establishment and operation will be facilitated and supported by the Private Sector Participation (PSP) Contractor. Note: procedures for the establishment of compulsory WUAs (as for the MPIDP) are diagrammed in Figure 8-2.

The PSP Contractor will also be responsible for arranging delivery of the necessary support services for vulnerable households, and for the associated household-level monitoring.

8.6.3 Cultural Heritage

Responsibility for cultural heritage lies with the ANRS Bureau of Culture, Tourism and Parks Development (BoCTPD) and its zonal and woreda counterpart offices (and at national level, with the ARCCH).

As recommended in the reconnaissance heritage survey (Annex 9), the Dembia Woreda Culture, Tourism and Parks Development Office should be included on the Woreda Project Implementation Team (WPIT), mainly to liaise with the religious authorities in the area (church elders and priests).

The PSP Contractor will arrange for the ARCCH to undertake the official heritage survey proposed by that authority as a follow-up to the ESIA's survey (see Annex 9 and Annex 12). The PSP Contractor will also arrange for appropriate archaeological expertise to be present within the construction supervision team, in discussion with the concerned authorities.

The PSP Contractor will also liaise with the local religious authorities, both directly and through the WPIT.

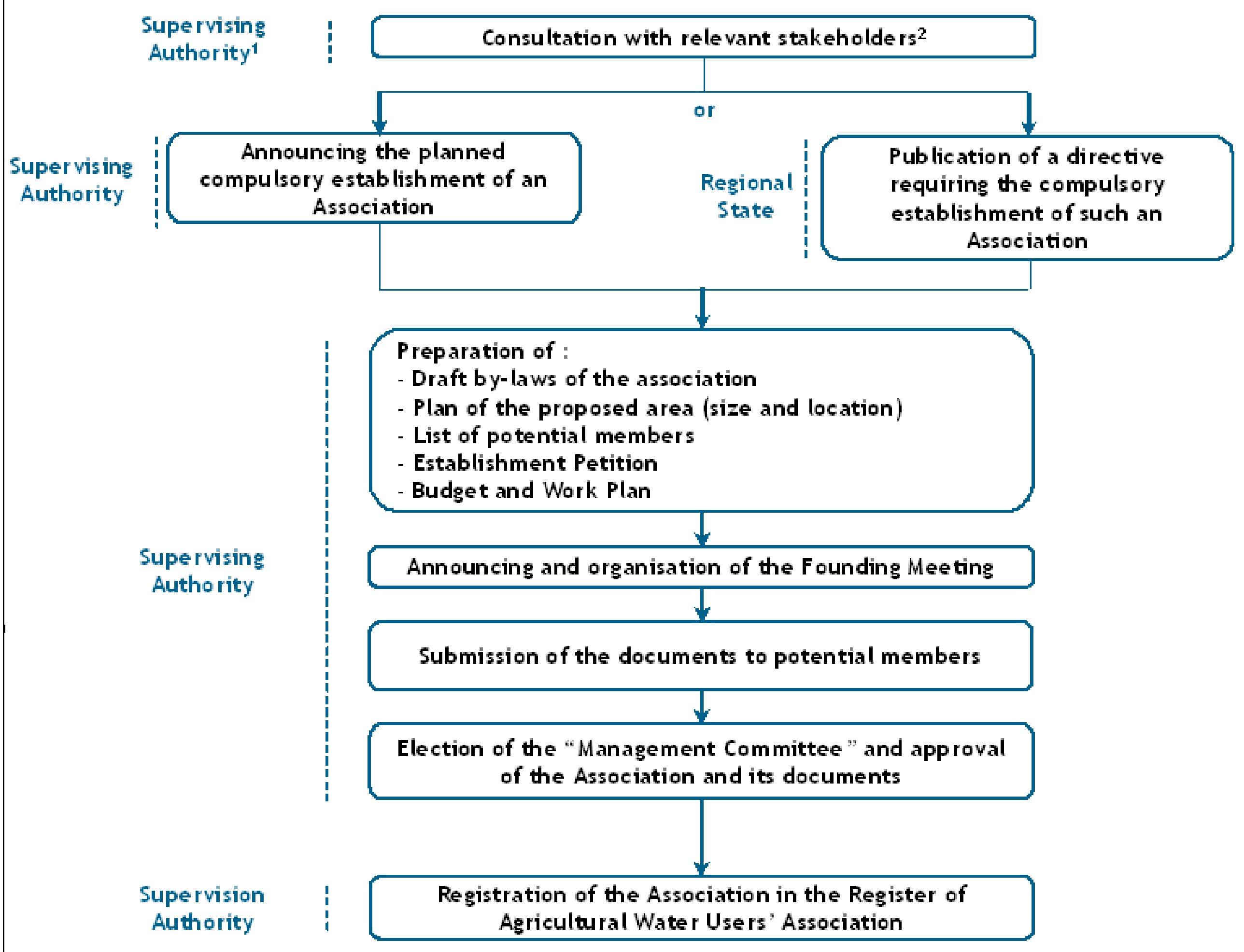
8.6.4 Agricultural Inputs and Services

The PSP Contractor will be responsible for supporting WUAs both institutionally, for group formation and operation, and technically, for on-farm land development and subsequent agricultural operations.

ENIDP Component 2, Agricultural and Market Development, and Component 3, Irrigation Management, will provide support for various aspects of agricultural service and input delivery and links to markets through the various levels of government and specialised regional agencies such as the Amhara Regional Agricultural Research Institute (ARARI).

As noted in the ESIA analysis, details of delivery of many of the agricultural services and inputs needed for successful implementation of the scheme remain to be prepared (see Section 5.4.10.3 and Measures PO25.1, PO25.3 and PO38.1). The PSP Contractor will have a major role both in identifying the need for specific activities during project operation and in arranging for delivery of them. The necessary flexibility has been built into the ToR for the Management Services Contract.

Figure 8-2: Procedures for Establishment of Compulsory WUAs



[1] – Regional Bureau of Water Resources or such other Bureau, authority or agency designated by a Regional State as responsible for organizing and registering Associations
[2] – Including potential members of a new Association

Note: this procedure concerns modern canal networks constructed following the entry into force of the proclamation.

Source: consultant

8.6.5 Socio-economic Services and Community Development

Successful uptake and operation of the project depends on a number of key social interventions. In addition to roads, these are (i) safe domestic water supplies, (ii) universal adult literacy and numeracy, and (iii) improved health care. Numerous other project activities and environmental and social measures will require full participation by command area residents. Government resources for delivery of these programmes and measures is extremely limited, and they will need to be funded and implemented by the project. The logical detailed planning and/or delivery mechanism is the PSP Contractor, if necessary on a flow-through basis to, e.g., specialised agencies or NGOs. Measures requiring urgent physical construction (for example, wells and training centres) could be carried out by the Construction Contractor as an additional task.

8.6.6 Health

The responsible bodies are the ANRS BoH and its counterpart organisations at lower level, both in North Gonder Zone and in Dembia Woreda (WorHO).

It is understood that the BoH intends to establish a working group to develop an appropriate management structure to cope with the health impacts and health requirements of MPIDP and RIDP, perhaps by expansion of the role and capabilities of the existing Koga-related health committee.

8.6.7 Fisheries

Fisheries are the responsibility of the ANRS Bureau of Agriculture and Rural Development (BoARD).

All fishery measures should be implemented through the Dembia Woreda Agriculture and Rural Development Office (WoARD) acting under the BoARD. Additional fisheries staff and training will be provided at Woreda and Kebele levels through the FAO-sponsored Lake Tana Fishery Management Plan through Community Participation. The project's specific fisheries measures (see ESMP tables and Annex 12) should be coordinated by the PSP Contractor in close consultation with the BoARD, WoARD, the new Kebele Fish Management Units (to be established in 2011) and the local fishers' cooperative.

Collaborating organisations would be Bahir Dar University (BDU), Bahir Dar Fisheries and Aquatic Life Research Centre (BFALRC), and NGOs such as Fish for All.

8.6.8 Water Management - Regional Level

8.6.8.1 General Recommendation: Strengthen ABA

Lake Tana is a multipurpose lake which has become a source of conflict for the different stakeholders such as farmers, fishermen, ferry operators, local inhabitants and authorities[107]. Currently there is no powerful operational platform that brings these different stakeholders together. Development activities that require water are not integrated. Therefore, there is a strong need to establish an organisation that will bring the different stakeholders together, to enhance a more harmonious development context and ensure sustainable use of the water resources.

The increase in water uses will have an important impact on the lake's water balance. It is necessary to rationally manage water uses and monitor their effects, and to be able to enforce management decisions in the case of negative impacts. Water resources planning should be the responsibility of a public organisation such as the Abbay Basin Authority (ABA)[108].

As mentioned in Section 6.7, it is highly recommended that ABA elaborates a Lake Tana water resources management plan, together with all the stakeholders. Such a plan would:

- Analyse the water resources and the water uses in the Tana and Beles basins.
- Clarify the water management roles of the various stakeholders.
- Use basin planning tools (see below) for assisting stakeholders in planning the management of the Tana Beles water system (including the prioritisation of the water uses).
- Reflect the negotiations between the various stakeholders during the participatory process.
- Include an action plan with priority water management actions, including the action to update the plan in a medium term future.

8.6.8.2 Decision Support System for Water Management

The Consultant recommends the use of a computer-based transparent and integrated DSS for water resources planning in the Tana-Beles water system.

The extent to which a DSS can contribute to better and more sustainable decision-making depends on various factors, including the way in which decisions would have been made in their absence. Numerous approaches to DSS for dam planning and operation have been developed over the years. Which DSS, or even type of DSS, is most appropriate in any given situation depends on a range of factors, including what types of decision are being made and for whom the output is required. Clearly DSS are only beneficial when they provide data and information that is recognised as useful and is valued by the decision maker(s). A DSS that does not provide this will not be used; they must be useful in the real world.

Ideally, a DSS used in water management contributes to decision-making processes, so as to:

- facilitate examination of the wider social and ecological context of a particular water development (infrastructure, rules…);
- assist in conflict mitigation, enabling compromises to be found;
- enable integration of more and diverse sources of information from different scientific disciplines, but also include non-scientific inputs;

107 This assessment is largely detailed in Vijverberg J. et all (2009).

108 According to *BRLi & T&A (2008).*

- sharpen the focus on stakeholder involvement in decision-making so that all stakeholders participate from early in the process;
- facilitate negotiation-based approaches to decision-making that hopefully lead to increased cooperation and consensus building between different stakeholders.

Table 8-9 shows some examples of DSS existing in the Nile River basin, plus the Tana-Beles DSS to come. They all should be integrated in the Nile Basin DSS (under development), or at least allow links with the Nile Basin DSS.

Table 8-9: Examples of Computer-based DSSs used for Water Resource Planning in the Nile River Basin

DSS	Description
Lake Victoria Decision Support Tool (LVDST)	Database, utility tools (i.e., to process and prepare data) and control models have been combined to support long range planning and short range operation of the Lake Victoria reservoirs and hydropower units. Allows short-term hydropower production to be optimized within constraints imposed by long range planning decisions (Georgakakos 2006).
The High Aswan DSS	Decision support for the Egyptian Ministry of Water and Irrigation. Comprises various decision/optimization models relating to reservoir releases for irrigation, energy generation and flood protection (Georgakakos 2006).
NileSim	Simulation model of the water resources of the entire Nile Basin. Developed primarily as a learning tool to explain complex river behaviour and management to non-technical people. Enables scenarios to examine the effects of policy options and changes caused by manipulating dams and regulating river use (Levy & Baecher 2006).
River Basin Simulation Model (RIBASIM)	This water balance simulation model enables evaluation of measures related to infrastructure, operational and demand management. It generates water distribution patterns and provides a basis for detailed water quality and sedimentation analyses in river reaches and reservoirs. It has been used to simulate water flows in the whole of the Nile Basin as part of the Lake Nasser Flood and Drought Control project that aimed to evaluate risk and mitigation measures for different flood and drought control scenarios.
The Nile Decision Support Tool (Nile DST)	Developed as part of the FAO, Nile Basin Water Resources Project to objectively assess the benefits and tradeoffs associated with various water development and sharing strategies. Comprises six main components: databases, river simulation and management, agricultural planning, hydrologic modelling, remote sensing and user-model interface (Georgakakos 2003; Georgakakos 2006).
Global Water Availability Assessment (GWAVA) model	This model provides a global/regional or catchment scale approach to modelling hydrology and assessing water resource availability. It provides assessments of water availability on a spatial basis (GIS), in terms of indices of water supply vs. water demand. It enables impacts of climate and population change to be investigated and can also be used to look at land-use change impacts and development of hydropower schemes. It has been used to simulate regional water resources across eastern Africa, including the Nile Basin (Meigh *et al.* 1998).
Water Evaluation and Planning (WEAP) model	A simulation model developed to evaluate planning and management issues associated with water resource development. WEAP can be applied to both municipal and agricultural systems and can address a wide range of issues including: sectoral demand analyses, water conservation, water rights and allocation priorities, stream flow simulation, reservoir operation, ecosystem requirements and project cost-benefit analyses (SEI 2001). The model has been applied to assess water resource development scenarios in the Nile catchment.
Tana-Beles DSS	To be developed, maybe based on the existing Tana-Beles water allocation model (Mike Basin software – model elaborated by SMEC (2008)).
Nile Basin DSS	Under development, by ENTRO.

Source: McCartney et al. (2006).

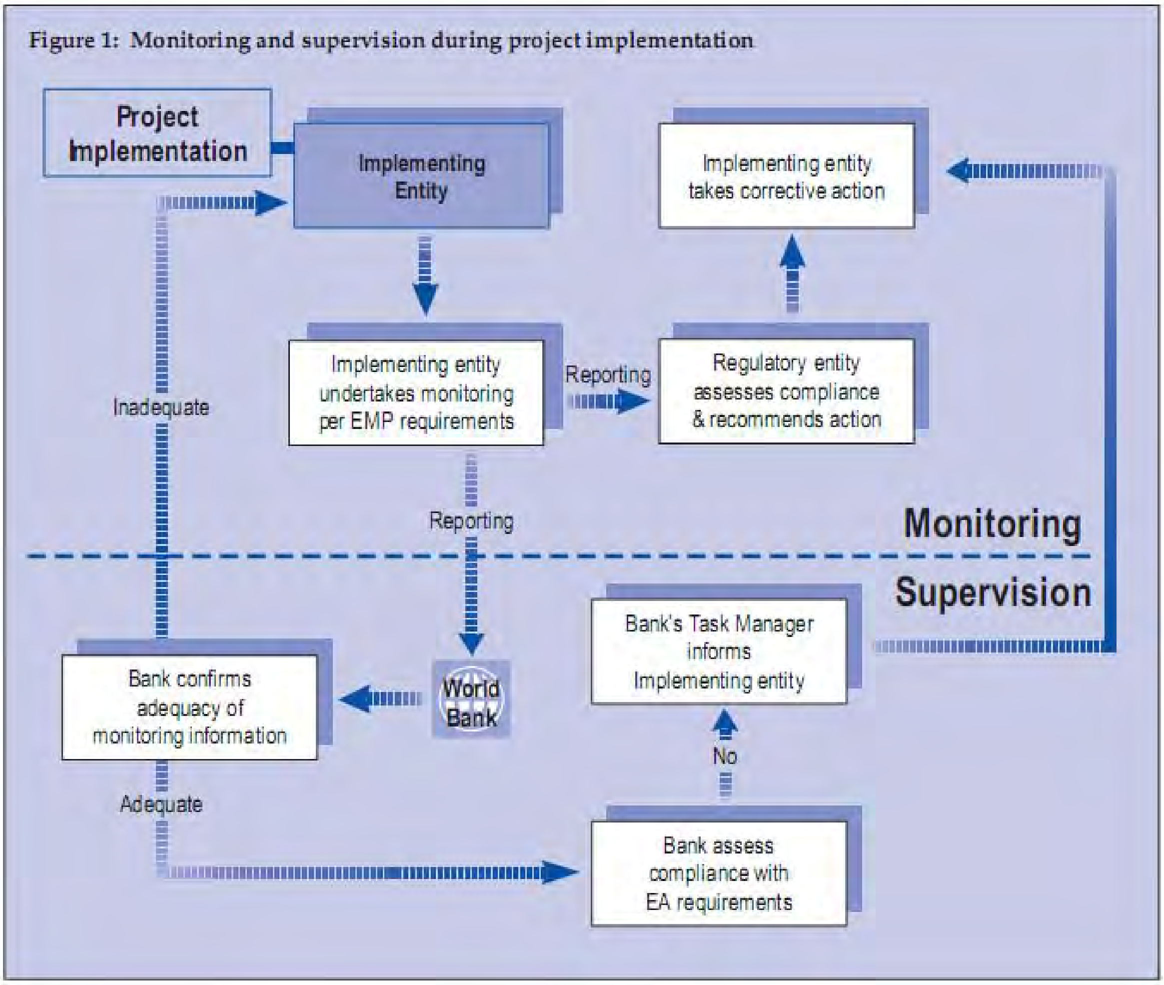
8.6.9 Monitoring

The Bank's experience shows that "projects with potentially large, significant and uncertain environmental impacts will normally require more intensive supervision" (WB 1996). The Bank's monitoring process is diagrammed in Figure 8-3.

Monitoring of the project's environmental and social impacts will be uncoordinated due to multiple and separate sectoral responsibilities unless a single central body is allocated this responsibility and resourced to do the work effectively. In practical terms, this will be done most easily by the PSP Contractor; the ToR for the Management Services Contract include a major monitoring and information management role.

Since the PSP Contractor will also be responsible for many aspects of the project's environmental and social performance, a conflict of interest situation may develop. This will be avoided by subjecting the PSP Contractor to independent monitoring by (i) the regional BoEPLAU, (ii) MoWE's ENIDP M&E unit (established and operating under ENIDP Component 4.2), (iii) independent auditors required for verification of the contractor's EMS and social responsibility systems, (iv) the Panel of Experts and/or Independent Expert, and (v) periodic Bank supervision missions.

Figure 8-3: Monitoring and Supervision during Project Implementation



Source: World Bank (1996)

8.7 COSTS

8.7.1 Notes on Costs

The total cost of the environmental and social mitigation and enhancement measures including monitoring is estimated at USD 2.0 million over 8 years (see Table 8-10). This total excludes:

(i) land acquisition and compensation. resettlement, land redistribution and consolidation, and associated institutionation support and support for vulnerable households - these costs are to be detailed in the RAP;

(ii) malaria control and some other health measures and health monitoring - full details of these activities are to be developed by the ANRS Bureau of Health; a nominal sum of USD 100,000 has been included for health and safety during construction, as well as USD 30,000 for the necessary public HIV/AIDS prevention programme during construction;

(iii) a number of measures identified as being important for project success but which are not strictly environmental and social mitigation measures, including (a) capital investments, including precise land levelling to enable accurate in-field soil and water management (a major cost item estimated at USD 800/ha), upgrading the Kola Diba to Guramba track to provide reliable command area access from the north, building the community link roads to all-weather standard, and providing safe domestic water supplies (shallow wells) throughout the command area (a developmental priority), (b) support for WUA formation and operation, (c) agricultural and agronomic activities (research, extension and training, implementation of livestock, mechanisation, beekeeping and pest management plans, (d) contributions to regional initiatives on agrobiodiversity, fisheries (hatchery), and (e) community development activities (for example, upgrading the education system) not already included.

The identifiable cost of these measures is estimated at USD 5.6 million, of which the bulk (USD 3.8 million) is for capital investments, mainly precise land levelling (USD 3.2 million) (see Table 8-10).

The cost table includes nine nominal items for technical assistance (TA) to help decision-makers formulate details of various required or recommended measures and programmes. During pre-construction these include (i) the project's livestock husbandry programme (PO25.1), (ii) the project's mechanisation programme (PO25.3), (iii) the project's health programme (PO33.1), and (iv) the project's integrated community development programme. During construction the TAs are (v) for preparation of the Phase 2 PMP (CO13.1), (vi) for preparation of a beekeeping support programme (with potentially much higher returns than canal aquaculture: CO13.4), and (vii) for specialised review of fish passage issues (a cost which can be shared with the Ribb irrigation and drainage project). During project operation the two TAs identified are (viii) to help Dembia Woreda develop a practical waste management plan (O11.6), and (ii) to facilitate a discussion on the strategic merits and practical implications of converting to organic production (O13.3).

Since details of these programmes will not be available until completion of the respective TAs, the costs for their implementation remain to be determined (TBD).

8.7.2 Cost Attribution

Many of the measures in the ESMP relate to project planning and preparation, or are standard best practice during construction, as a management overhead. Therefore no costs are attributed to them in the ESMP tables (Table 8-4, Table 8-5, Table 8-6). Measures with costs are listed in Table 8-10.

Table 8-10 includes two "cost attribution" columns, Environmental/Social and Other. This has been done to differentiate between costs reasonably categorised as environmental and/or social, and costs which relate to (i) land acquisition and consolidation, construction (such as health and safety), (ii) capital investments (such as building the community roads to all-weather standards, precise land levelling, and the installation of safe domestic water supplies and their associated maintenance), (iii) agricultural activities (training and extension, livestock husbandry, agronomic research, pest management), and (iv) community development activities not strictly required for mitigation (such as expansion of the local educational system to higher grades).

All health measures have been categorised as environmental/social, except for the nominal allowance for health and safety on site mentioned above.

The technical assistance input required to develop further details of the health measures, together with the TAs for the recommended integrated community development programme, the Phase 2 PMP, beekeeping, organic agriculture and waste management planning have all been categorised as environmental/social.

Table 8-10: ESMP: Indicative Cost Table (USD '000)

Note: all totals exclude items (a) included in RAP, (b) to be determined by other agencies and/or through specialist TA

Ref.	Measure	Project Year										Cost Attribution	
		0	1	2	3	4	5	6	7	8	Total	Env/Soc	Other
Pre-construction													
PC15.x, PC16.x, PC18.2	Land acquisition, compensation, resettlement, land redistribution	See RAP									See RAP		See RAP
PC18.1	Accelerated establishment of WUAs	50									50		50
PO1.1	Full scale ag. trial with monitoring	50									50		50
PO12.1	Targetted research on crop pests	25									25		25
PO25.1	TA to develop practical livestock programme	20									20		20
PO25.3	TA to develop practical mechanisation programme	20									20		20
PO33.1	TA to facilitate development of practical health programme	20									20	20	
PO39.1	TA to facilitate development of practical integrated social development programme	20									20	20	
	Sub-total	***205***									***205***	***40***	***165***
Construction													
C7.1	Health & safety measures		40	30	30						100		100
C8.2	HIV/AIDS IEC programme for public		15	10	5						30	30	
C13.1	ARCCH heritage survey		20								20	20	
C13.2	Archaeological supervision		6	4	2						12	12	
C13.3	Train equipment operators in artefact recognition		1								1	1	
C14.1	WUA support		50	50	50						150		150
C19.1	Additional crossings		5	10	10						25		25
CO1.1	Continue full scale farm trial		25								25		25
CO2.1	Precise land levelling			784	2,448						3,232		3,232
CO12.1	Targetted research on crop pests & diseases		24	24	24						72		72

Ref.	Measure	Project Year										Cost Attribution	
		0	1	2	3	4	5	6	7	8	Total	Env/Soc	Other
CO13.1	TA to assist preparation of Phase 2 PMP		33								33	33	
CO13.3	Targetted research for IVM		12	12	12						36		36
CO13.4	TA to develop beekeeping programme			10							10	10	
CO20.1	TA to review fish passage designs		16								16	16	
CO20.2	Wet season fish survey		20								20	20	
CO23.1	Adult literacy campaign		20	20	20						60	60	
CO23.3	Support for local groups		24	24	24						72	72	
CO24.2	Enhancement of Women's Affairs capacity		12	12	12						36	36	
CO25.1	Livestock programme		TBD	TBD	TBD						TBD		TBD
CO25.4	Livestock watering points			5	5						10	10	
CO27.1	Build community roads to all-weather standard			25	20						45		45
CO27.2	Upgrade Kola Diba - Guramba track			300							300		300
CO30.x	Malaria control		TBD	TBD	TBD						TBD	TBD	
CO31.1	Schistosomiasis control		12.5	12.5	12.5						37.5	37.5	
CO32.x	Various other health measures		TBD	TBD	TBD						TBD	TBD	
CO34.1	Provide safe domestic water		100	100							200		200
CO34.2	Water quality lab		25	10	10						45		45
CO35.1	Steps to canals		3	6	1						10	10	
CO39.1	Social development programme		TBD	TBD	TBD						TBD		TBD
Monitoring													
	HSE compliance		*64*	*64*	*64*						*192*		*192*
	Wetlands, birds, fish		*5*	*5*	*5*						*15*	*15*	
	Social		*See RAP*	*See RAP*	*See RAP*						*See RAP*		*See RAP*
	Health		*TBD*	*TBD*	*TBD*							*TBD*	
	Sub-total		***532.5***	***1,517.5***	***2,754.5***						***4,804.5***	***382.5***	***4,422***
Operation													
O2.1	Agricultural training and extension					50	50	50	50	50	250		250
O2.3	Tools and equipment					50	50	50	50	50	250		250
O3.1	Trials of SRI						25				25		25

Ref.	Measure	Project Year										Cost Attribution	
		0	1	2	3	4	5	6	7	8	Total	Env/Soc	Other
O8.2	Promotion of vetiver					4	4	4	4	4	20	20	
O9.2	Flood management plans					20					20	20	
O11.6	TA to develop waste management plans						20				20	20	
O12.1	Targetted research on crop pests & diseases					24	24	24	24	24	120		120
O13.1	Implement PMP					TBD	TBD	TBD	TBD	TBD	TBD		TBD
O13.2	Beekeeping programme					TBD	TBD	TBD	TBD	TBD	TBD		TBD
O13.3	TA on organic agriculture						20				20	20	
O14.2	Channel profiles and fish							10			10	10	
O15.3	IEC campaign on wildlife					2	2	2	2	2	10	10	
O18.1	Regional agrobiodiversity programme					15	15	15	15	15	75		75
O19.1	Lakeshore restoration project					67.5	35	35	35		172.5	172.5	
O20.1	Fisheries management					25	25	25	25	25	125	125	
O20.2	Canal aquaculture trial							78	78		176	176	
O20.3	Contribution to regional hatchery					50					50		50
O21.2	Fish entrainment research							5			5	5	
O23.1	Complete adult literacy campaign					10	10				20	20	
O23.6	Support for groups					24	24	24	24	24	120	120	
O24.7	Support for Women's Affairs office					12	12	12	12	12	60	60	
O24.8	Microcredit & income generation for women					20	20	20	20	20	100	100	
O25.1	Livestock programme					TBD	TBD	TBD	TBD	TBD	TBD		TBD
O25.4	Mechanisation programme					TBD	TBD	TBD	TBD	TBD	TBD		TBD
O26.1	Forestry / fuelwood programme					20	20	20	20		80	80	
O26.2	Efficient stove programme					10	10	10	10		40	40	
O26.3	Solar electrification programme					25	25				50	50	
O30.x	Malaria control measures					TBD	TBD	TBD	TBD	TBD	TBD	TBD	
O31.1	Schistosomiasis control					12.5	12.5	12.5	12.5	12.5	62.5	62.5	
O32.2	Health IEC campaign					10	10	10	10	10	50	50	
O32.x	Other health measures					TBD	TBD	TBD	TBD	TBD	TBD	TBD	
O32.10	Beneficiary financial training					5	5	5	5	5	25	25	

Ref.	**Measure**	**Project Year**										**Cost Attribution**	
		0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Total**	**Env/Soc**	**Other**
O32.13	Decision-maker sensitisation re HIV/AIDS					2	2	2	2	2	10	10	
O32.15	Beneficiary nutrition training					2	2	2	2	2	10	10	
O32.16	Homestead gardening & micro-enterprise support					25	25	25	25	25	125	125	
O32.18	Beneficiary safety training					5	5	5	5	5	25	25	
O34.1	Maintain safe water					10	10	10	10	10	50		50
O35.2	Safety training for farmers					5	5	5	5	5	25	25	
O38.1	Agricultural services and inputs					TBD	TBD	TBD	TBD	TBD	TBD		TBD
O39.1	Social development programme					TBD	TBD	TBD	TBD	TBD	TBD		TBD
Monitoring													
	HSE compliance					*2*	*2*	*2*	*2*	*2*	*10*	*10*	
	Soil & water quality					*24*	*24*	*24*	*24*	*24*	*120*		*120*
	Transport, equipment & running costs for soil & water quality monitoring					*40*	*6*	*6*	*6*	*6*	*64*		*64*
	Wetlands, birds					*3*	*3*	*3*	*3*	*3*	*15*	*15*	
	Fish, inc. flows					*4*	*4*	*4*	*4*	*4*	*20*	*20*	
	Social					*24*	*24*	*24*	*24*	*24*	*120*	*120*	
	Transport & running costs for social monitoring					*35*	*6*	*6*	*6*	*6*	*59*	*59*	
	Health					*TBD*	*TBD*	*TBD*	*TBD*	*TBD*	*TBD*	*TBD*	
	Sub-total					***562***	***524.5***	***517.5***	***502.5***	***359.5***	***2,609***	***1,605***	***1,004***
	TOTAL	**205**	**532.5**	**1,517.5**	**2,754.5**	**562**	**524.5**	**517.5**	**502.5**	**359.5**	**7,618.5**	**2,027.5**	**5,591**

Source: Consultant's estimates

9. Conclusions and Recommendations

9.1 Conclusions

9.1.1 Compliance with WB Safeguard Policies

Subject to full resourcing and effective implementation of the measures identified in this report, the project is considered to be in compliance with World Bank safeguard policies 4.01 Environmental Assessment, 4.04 Natural Habitats, 4.09 Pest Management, and 4.11 Physical Cultural Resources.

The ESIA study team did not identify any sector of the local population who should be termed "indigenous people" in the sense implied by the Bank's policy 4.10 Indigenous People, and therefore this policy does not apply. Similarly, there are no forests in the area and the project does not involve a dam, so policies OP 4.36 Forests and OP 4.37 Safety of Dams do not apply.

Compliance with the Bank's policy on Involuntary Resettlement (OP 4.12) is the subject of a separate consultancy to prepare a Resettlement Action Plan (RAP) consistent with the Bank's policy and Ethiopian legislation.

Compliance with policy OP 7.50 Projects on International Waterways will be handled by MoWE through Nile Basin consultative processes.

9.1.2 Risks

The project is a bold attempt to transform agricultural production methods and yields and at the same time radically change living conditions in a very poor and socially conservative rural society living in a difficult physical location with sensitive ecological values. This approach carries with it a number of risks, economic, institutional, social and biophysical.

Major risks of which the project's sponsors should be aware include:

- Ecological: negative impacts on globally threatened fish and migratory birds.
- Physical: groundwater rise and secondary salinisation.
- Economic: market inelasticity.
- Social: slow uptake of benefits due to 'cultural resistance'.
- Organisational: slow uptake of benefits due to inadequate delivery of essential agricultural and non-agricultural inputs and services.

Water availability and climate change are not risks for this particular project.

There is no previous experience of successful implementation of large scale, modern, commercial smallholder irrigation in the Ethiopian highlands, and therefore these risks are significant. At the same time, existing living conditions are unacceptable, the environment is under high stress, and change is imperative.

With respect to the various risks: (i) mitigation and offset measures can mitigate impacts on wildlife; (ii) the technical difficulties of maintaining soil quality will be significant. However, this and other technical challenges concerning soil and water management are likely to be easier to resolve than the social and institutional challenges, especially those relating to land reallocation, reorganisation of settlements, farmer skills and resources for commercial irrigated agriculture, labour availability, on-farm maintenance, service provision and marketing, the service delivery model, impacts on women, impacts on the non-beneficiary population outside the command area, and social change.

9.2 Recommendations

9.2.1 Strategic Actions

The assessment indicates that **two strategic actions** should be taken to help ensure the project's feasibility and enhance its sustainability:

(i) Review the project's framework to confirm that mechanisms and funds have been identified for sustainable delivery of *all* the services and inputs essential for uptake of the economic opportunities created by dry season water availability, including the necessary social investments (safe water, health, literacy, lighting, etc) as well as agricultural services and supplies.

(ii) Recognise the regional nature of some of the impacts and sustainability issues, and initiate responses at this level (specifically: health, wetland protection and recovery, fisheries management, IPM and agrobiodiversity, and cumulative effects).

9.2.2 Next Steps

As a management *aide memoire*, a checklist of 7 key actions considered necessary in the Pre-Construction Phase is given in Table 9-1 (for details see the corresponding items in the ESMP, Chapter 8, and impact analysis, Chapter 5).

Table 9-1: Recommended Priority Actions

No.	Action	Comment
1	Ensure that the project implementation concept and implementation mechanisms cover *all* the services and inputs necessary for success (agricultural, social, non-irrigation infrastructure) and for the protection of non-beneficiary producers from price shocks (flooded markets).	ENIDP Components 2 and 3 cover some of these actions.
2	Re-visit the concept of full irrigation development within existing settled areas in the light of (i) the impacts and health hazards associated with this activity, and (ii) the possibility of later, phased village reorganisation.	
3	Ensure that the tender documents include comprehensive HSE, labour welfare and social provisions, that the BoQ includes some HSE pay items as incentives, that the HSE enforcement and compliance mechanisms are clear, and that the supervision consultant is resourced and tasked for HSE compliance.	See relevant sections of this ESIA, including the recommendations at Annex 10
4	Establish a formal regional working group chaired by the ANRS BoH to follow up the findings of the Rapid Health Appraisal.	See Annex 7
5	Establish a formal working group chaired by ANRS BoARD to follow up the recommendations of the Phase 1 PMP.	See Annex 8
6	Initiate a regular seasonal bird count in the Dembia Plain, commencing in the dry season 2010-11.	
7	Accelerate establishment and capacity build-up of the ABA Lake Tana sub-office, including the development of firm lake level operating rules which cannot be over-ridden by EEPCo.	

Source: Consultant

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