NILE BASIN INITIATIVE

Eastern Nile Subsidiary Action Programme

EASTERN NILE TECHNICAL REGIONAL OFFICE (ENTRO)

EASTERN NILE MULTI-SECTORAL INVESTMENT OPPORTUNITY ANALYSIS

Strategic Scoping of EN Multi-Sectoral Investments

March 2015

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ACRONYMS AND ABBREVIATIONS

AfDB	African Development Bank
AHD	Aswan High Dam
BCM	Billion Cubic Meter
BSG	Benishangul Gumuz Region
CC	Country Consultation
COMESA	Common Market for Eastern and Southern Africa
CRA	Cooperative Regional Assessment
CRGE	Climate Resilient Green Economy
EAC	East African Community
ECCAS	Economic Community of Central African States
ECGLC	Economic Community of the Great Lakes Countries
EEPCO	Ethiopian Electric Power Corporation
EIA	Environmental Impact Assessment
EN	Eastern Nile
ENID	Eastern Nile Irrigation and Drainage
ENCOM	Eastern Nile Committee Of Ministers
ENIMIS	Establishment of Eastern Nile Irrigation Management Information System
ENPT	Eastern Nile Power Trade
ENSAP	Eastern Nile Subsidiary Action Plan
ENSAPT	Eastern Nile Subsidiary Action Plan Team
ENTRO	Eastern Nile Technical Regional Office (NBI)
EWUAP	Efficient Water Use for Agricultural Production
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
GEF	Global Environment Facility
GERD	Grand Ethiopian Renaissance Dam
GIS	Geographic Information System
GWh/y	GigaWatt hour/year
HCENR	Higher Council for Environmental and Natural Resources
HDI	Human Development Indices
HSU	Hydrological Similar Units
IDEN	Integrated Development of Eastern Nile
IGAD	Inter-Governmental Authority on Development
IMF	International Monetary Fund
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature and Natural Resources
IWMI	International Water Management Institute
IWRM	Integrated Water Resource Management
JICA	Japan International Cooperation Agency
JMP	Joint Multipurpose Project
MCA	Multi Criteria Analysis
MEDIWR	Ministry of Electricity, Dams, Irrigation and Water Resources
MoE	Ministry of Environment
MoWI	Ministry of Water and Irrigation
MSIOA	Multi Sector Investment Opportunity Analysis
MW	Mega Watt
NBI	Nile Basin Initiative

NCORE	Nile Cooperation for result project
NELCOM	Nile Equatorial Lakes Council of Ministers
NELSAP	Nile Equatorial Lakes Subsidiary Action Programme
NELSAP-CU	NELSAP Coordination Unit
NELTAC Nile	Nile Equatorial Lakes Technical Advisory Committee
NGO	Non-Governmental Organization
NIB	National Irrigation Board
Nile-COM	Nile Council of Ministers
NWRMS	National Water Resources Management Strategy
OMM	Operation, Maintenance and Management
PMU	Project Management Unit
PRSP	Poverty Reduction Strategy Programme
RATP	Regional Agricultural Trade and Productivity Project
RPSC	Regional Project Steering Committee
RSS	Republic of South Sudan
SAP	Subsidiary Action Programme
SVP	Shared Vision Programme
UNDP	United Nations Development Programme
WB	World Bank
WRMA	Water Resources Management Authority
WRMD	Water Resources Management and Development
WSTF	Water Services Trust Fund
WUA	Water Users Association

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1. Introduction and Background

1.1 The NBI

The **Nile Basin Initiative (NBI)** is a partnership between the riparian states of the Nile River: Burundi, Democratic Republic of Congo, Egypt, Ethiopia, Kenya, Rwanda, South Sudan, Sudan, Tanzania and Uganda. The NBI seeks to **develop the river in a cooperative manner, share substantial socio-economic benefits, and promote regional peace and security.** The NBI started with a participatory process of dialogue among the riparian countries that resulted in an agreement on a shared vision, namely, to "achieve sustainable socioeconomic development through the equitable utilization of, and benefit from, the common Nile Basin water resources," and a Strategic Action Programme to translate this vision into concrete activities and projects.

The **Eastern Nile Subsidiary Action Programme** (ENSAP) of the NBI was launched by Egypt, Ethiopia and the Sudan (with South Sudan joining in 2012) to **initiate concrete joint investments and action on the ground** in the Eastern Nile sub-basin in the areas of power generation and interconnection, irrigation and drainage, flood preparedness and early warning, watershed management, development of planning models and joint multipurpose programmes. ENSAP is governed by the Eastern Nile Council of Ministers (ENCOM) and implemented by the Eastern Nile Technical Regional Office (ENTRO) in Addis Ababa, Ethiopia. Funding for ENSAP accrues from Eastern Nile countries and varied bilateral and multilateral development partners.

1.2 NCORE and Earlier Initiatives

The Integrated Development of the Eastern Nile (IDEN), the first ENSAP project, was agreed in 2002 with a first set of seven sub-projects aimed at tangible win-win gains in the areas of watershed management, flood preparedness, early warning and response, irrigation and drainage, power supply interconnection and regional power trade and later the Joint Multipurpose Programme [JMP]. Some of these projects have successfully completed their preparations, and are advancing to implementation.

As part of implementing the projects identified for the 5 year Strategic Plan period, NBI has applied for funding from the Nile Basin Trust Fund/Cooperation in International Waters in Africa entitled Nile Cooperation for Results Project (NCORE) supporting the three NBI centres – the Nile-SEC, NELSAP-CU and ENTRO.

The Nile Cooperation for Results (NCORE) Project is the first phase of the Nile Basin Climate Resilient Growth Programme and is part of the overall NBI Strategic Plan. The **development objective of the NCORE is "to facilitate cooperative water resource management and development in the Nile Basin."** The Project comprises the following three components:

- Component 1: Advancing Nile Basin-Wide Cooperation and Analysis: This Component will support activities at the NBI Secretariat related to its core functions of Facilitating Cooperation and Water Resource Management
- Component 2: Promotion of Sustainable Development and Planning in the Nile Equatorial Lakes Region: This will support the NBI in its efforts to advance investment opportunities in the Nile Equatorial Lakes region

- Component 3: Promotion of Sustainable Development and Planning in the Eastern Nile Region: **This Component will support NBI in promoting cooperative activities, water resource management and sustainable development in the Eastern Nile**.

Component 3, for ENTRO, will support results related to its core function under two sub-programmes:

- The first provides a foundation for improved understanding of issues specific to the Eastern Nile sub-basin and aims to improve public domain access to the Eastern Nile knowledge base while
- The second promotes holistic approaches to preparing and operating water investments, to better take into consideration and communicate environmental and social issues.

1.3 THE EASTERN NILE MSIOA

1.3.1 Overview and Rationale

The EN-MSIOA study is one of several specific studies that is being undertaken to achieve the general objective of the NCORE from the Eastern Nile perspective.

Rapid Population growth, severe land degradation, and lack of adequate storage infrastructure are among the key challenges that have hindered development in the Eastern Nile (EN). The findings of the Cooperative Regional Assessment studies conducted by ENTRO for the ENSAP Projects reveals the followings:

- Unilateral, uncoordinated planning of expansions and Lack of "no-borders" analysis /basin-wide perspective for irrigation development in the EN could lead to Water Conflict in the EN Region. The projected water requirement per EN country master plans is estimated to be 108 BCM/Year.
- The EN region has huge untapped Hydropower potential. There is a need for a coordinated investment plan in power trade
- Through the Cooperative Regional Assessment (CRA), Power generation and interconnection, irrigation and drainage, watershed management as well as the Joint Multi-purpose Project have provided valuable information. However, the assessments have not been carried out from the wider basin resource optimization and efficiency considerations.

A multi sector investment opportunity assessment (MSIOA) is thus needed **to identify a coordinated water infrastructure investment strategy for the EN, comprised of prioritized water-related investments (regional or national with regional significance), that promotes shared, sustainable economic growth and development in the EN region.**

1.3.2 Objective of the Study

The overall objective is to develop a regional water investment strategy for the EN region that broadly supports socio-economic development, poverty reduction, and the reversal of environmental degradation.

1.3.3 Approach and Methodology

The EN-MSIOA study is being carried out over a 12 months and in addition the already Inception Phase (Task 0) has been divided into four (4) main tasks:

- Task 1: Inventory and Situation Analysis;
- **Task 2: Strategic Scoping of EN Multi-Sectoral Investments**;
- Task 3: Multi-Sectoral Analysis of Investment Opportunities;
- Task 4: MSIOA Final Products.

The methodology, as already presented in the Inception report is shown in **Figure 1-1**.

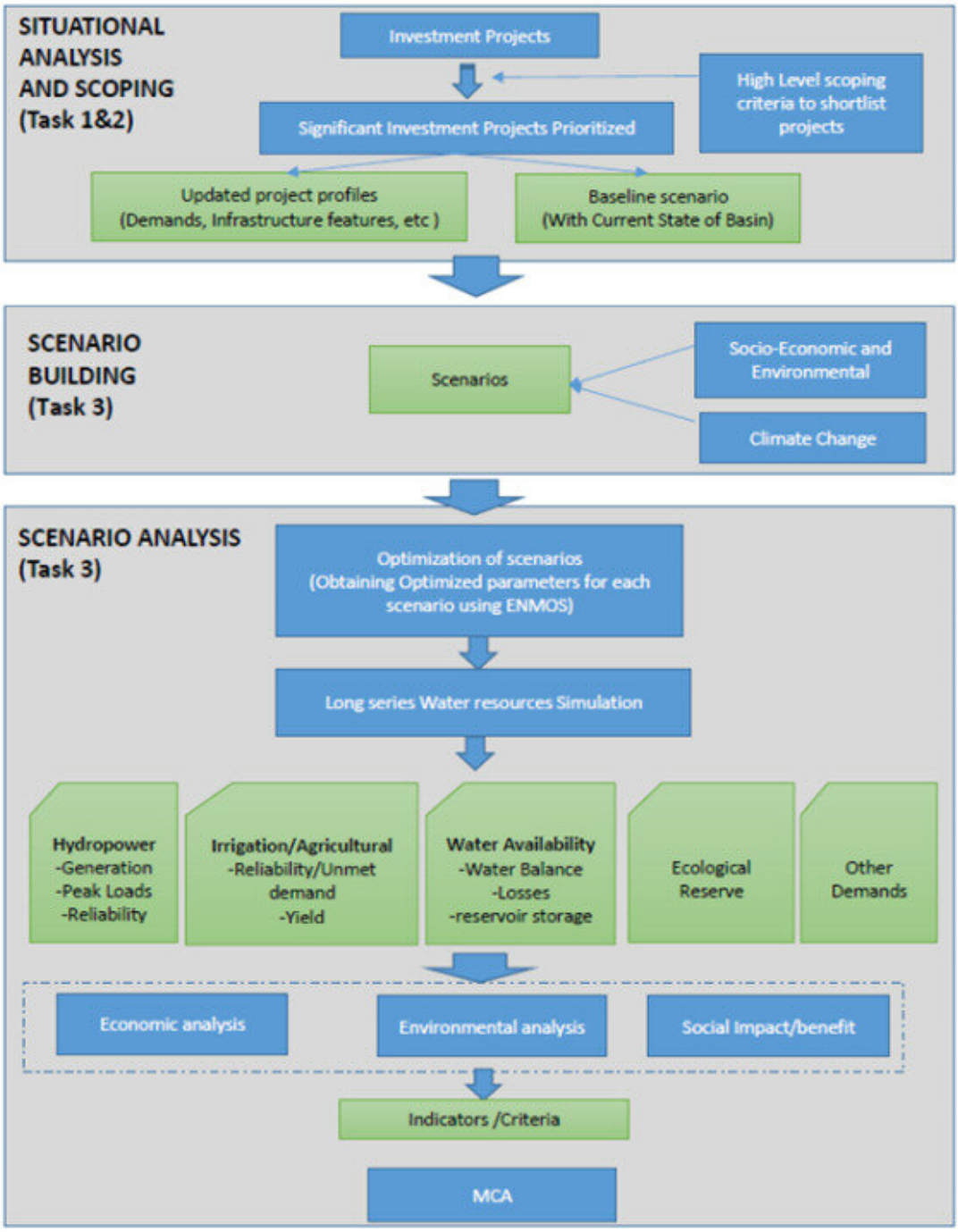


Figure 1-1: Methodology as set out in the Inception Report

1.3.4 This report: Strategic Scoping of EN Multi-Sectoral Investments

This Strategic Scoping of EN Multi-Sectoral Investments situational Analysis Report is divided into six chapters, structured as follows :

- Chapter 1 provides a very brief introduction to the NBI, ENTRO and the associated programmes that provide the context for this study. It also introduces the MSIOA study, how it is being tackled and how this report fits into the study.
- Chapter 2 aims to provide a socio-economic and environmental baseline in the form of a context for the scoping and prioritisation of interventions. It links back to the Situational Analysis and provides a synthesis of the key orientations that came out of that report. It also provides a water resources baseline, essentially the water balance for each sub-basin.
- Chapter 3 is concerned with the scoping of investments and looks at the different types of interventions that may be considered and what sort of scoping criteria can be used to evaluate potential interventions for inclusion on the MSIOA. It also includes the analysis of an increasing water resources development load on the water resources of the basin, through the analysis of some exploratory scoping scenarios.
- Bearing in mind that the analytical framework can only provide the environmental and socio-economic indicators and based on these, the strategic directions for development, it is clear that the planning decisions have to be made by various stakeholders including Government departments and potentially affected stakeholders. Indeed, these Government Ministries already have sectoral master plans in place and the aim has to include all the projects included in these (and more) in a basin-wide analysis. The types of sectoral interventions that will happen are discussed briefly in Chapter 4 before looking at who are the various stakeholders involved in planning, decision-making and implementation. This will be important when it comes to fine-tuning of the plan and implementation details.
- Based on the analysis of the scoping scenario, the results of which have been briefly presented in Chapter 2, Chapter 5 aims at identifying the developmental and management orientations that would be most sustainable both in terms of the environment and socio-economic benefits.
- Chapter 6 aims at providing a link to the next step of the study in which a limited number of favourable scenarios are investigated in more detail. The design of these core development scenarios should support the strategic directions that have emerged from the analytical scoping work described in this report, in particular in Chapters 2 and 5. A key part of the refined scenario work will include an economic analysis at the project level. Such an analysis will facilitate selection and prioritisation of projects as well as weighing up the relative benefits of irrigation and hydropower when they are competing for the same water.

2. Socio-economic and Environmental Baseline

2.1 Introduction

Establishing the socio-economic baseline is the first step in the scoping analysis and is aimed at understanding the status quo in terms of its impacts on the physical and socio-economic environments. Establishing the baseline is based on the findings of the situational analysis and through application of the preliminary analytical framework in order to understand the current water balance throughout the basin, and by sub-basin.

In Sections 2.2 the key orientations from the Situational Analysis are presented, first in general terms, and then by sector, looking at the issues, challenges and the opportunities for water resources development and management. This provides the necessary context for understanding which interventions are the priority ones.

2.2 Key Orientations from the Situational Analysis

2.2.1 Overview

2.2.1.1 Introduction

The Situational Analysis provided a detailed overview of the catchment characteristics and water resources of the Eastern Nile Basin and also provides the environmental baseline for each of the four sub-basins.

While levels of development have accelerated in some parts of the basin in recent years, it is clear that many areas remain very undeveloped despite the huge potential. A shortage of electricity and poorly developed infrastructure is a major challenge and none of the countries are food secure.

Two key components of the MSIOA will be the rapid development of both hydropower and irrigation to address these twin challenges and one of the main outputs of the Situational Analysis was the identification all the existing and potential development projects in these two sectors. The need for development in other sectors was also identified but hydropower and irrigation stand out because of their much greater need for the availability of sufficient water resources. In addition, the consumptive nature of irrigation can take water away from hydropower and may also have negative impacts on the environment. Similarly, while not a consumptive use of water, hydropower does require a regulated supply of water, often meaning the development of storage, and there are impacts associated with this, both positive and negative.

A very brief review of the socio-economic conditions in each of the sub-basins, based on the Situational Analysis, is provided in the following paragraphs

2.2.1.2 Abbay – Blue Nile Sub-basin

The findings of the Situational Analysis indicate that the Abbay section of the Abbay Blue Nile sub-basin is one of poorest and least developed areas in Ethiopia. Development is hampered by the poorly developed road infrastructure. The

establishment of hydro-power projects and irrigation schemes in the area will create an opportunity to improve the road network in this area and facilitate development.

The area is also the catchment for the Dinder and Rahad Rivers which rise in the north western section of the sub-basin and flow westwards before linking up with the Blue Nile in Sudan. The catchment areas represent one of the dwindling, relatively undisturbed natural highland areas in Ethiopia. Sections also fall within the Alatish Regional Park, which borders on the Dinder National Park in Sudan.

The Blue Nile section of the sub-basin falls within Sudan and contains some of the largest irrigation schemes in the world, such as the Gezira scheme. These schemes are largely located on the south western bank of the Blue Nile. There are also large rain-fed mechanised irrigation schemes located on the north eastern bank of the Blue Nile. The establishment of these large rain-fed schemes has resulted in conflicts between the farmers and pastoralists who traditionally used this area for grazing.

2.2.1.3 Baro-Akobo-Sobat and White Nile sub-basin

The findings of the Situational Analysis indicate that the Baro-Akobo-Sobat-White Nile sub-basin is the poorest and the least developed and populated sub-basin in the EN Region. Development is hampered by the poorly developed road infrastructure and regular flooding of large areas during the rainy season. The establishment of hydro-power projects and irrigation schemes in the area will create an opportunity to improve the road network in the area and facilitate development. However, the Baro-Akobo-Sobat-White Nile sub-basin is also the least disturbed sub-basin in the EN Region. The area consists of relatively undisturbed foothills of the Ethiopian Highlands in the north east. The Gambella National Park falls within this area. While the area to the west includes the Machar Marshes. The livelihoods of the local communities in the sub-basin are strongly dependent on the areas natural resources. The impact of the proposed hydro-power and irrigation schemes in the sub-basin will need to be carefully assessed in order to ensure that they do not severely impact on traditional livelihoods and the functioning of natural ecosystems. The area is also the least studied off the four sub-basins. A Strategic Social and Environmental Assessment (SSEA) for the area will commence in 2015.

2.2.1.4 Tekeze – Setit – Atbara Sub-basin

The findings of the Situational Analysis indicate that the Tekeze-Setit-Atbara sub-basin has the third lowest population of the four EN sub basins. The livelihoods of the majority of the population are linked to agriculture, with crop production and livestock herding the two most dominant economic activities within the sub-basin. Crop production associated with irrigation schemes occur in the Sudan section of the sub-basin. Rainfed agriculture is the dominant livelihood activity in the Ethiopian portion of the sub-basin. The infrastructure and access to services in the Sudan portion of the sub-basin are more developed than the Ethiopian section. However, there are frequent conflicts over access to natural resources, specifically grazing and water, between pastoralists and settled farming communities in Sudan. These conflicts have resulted in degradation of natural resources and increased poverty levels.

2.2.1.5 Main Nile Sub-basin

The findings of the Situational Analysis indicate that the Main Nile sub-basin is the most populated of the four EN sub basins. In the Sudan section of the sub-basin the livelihoods of the majority of the population are linked to irrigation agriculture along the banks of the Main Nile. Extensive irrigation is also practised in Egypt along the Main Nile

north of the High Aswan Dam and in the Nile Delta. Given the reliance on the Main Nile for water, water quality and water security are key issues, specifically for Egypt.

2.2.2 Sectoral and thematic overview

2.2.2.1 Introduction

Based on, and with reference to the Situational Analysis, the aim of this section of the report is to provide a rapid overview of the current situation by sector or thematic area, in order to provide the necessary context for the scoping of future interventions (including the continuation of existing/ongoing ones). Water resources management and development projects are driven by the need for them and therefore understanding this need at the national, regional, sub-basin and basinwide context provides an important backdrop for the scoping of investments.

2.2.2.2 Agriculture

2.2.2.2.1 Overview

Agriculture is the most important economic activity and plays a **major role in the lives and livelihoods of most households** in the EN countries, as well as **contributing significantly to overall economic growth and Gross Domestic Product** (GDP). A wide variety of crops are grown in the region both under rainfed and irrigation for domestic consumption and export. Rainfed agriculture, supported to some extent by small scale irrigation and water harvesting systems, is the dominant form of agriculture in the upstream countries (Ethiopia and South Sudan), whereas irrigated agriculture is dominant in the two downstream countries (Sudan and Egypt). Though there is huge potential (apart from Egypt) for rainfed agriculture, production level is low being largely subsistence and extremely vulnerable to climatic conditions. The main challenges include:

- **Food insecurity**; all the EN countries are food insecure and rely on importation of substantial amount of food crops to meet the growing demand,
- Policy issues: Absence of transboundary water agreements which bind all the four countries,
- Lack of finance for new investments and operation and maintenance
- Absence **of (bilateral) investment projects**, little involvement of the private sector, etc.
- Inadequate involvement of the private sector in development and service delivery,
- **Absence of regional trade** for agricultural products (Lack of market chains, agro processing facilities, infrastructure, etc)

However, there are also **significant opportunities**

- Potential to harmonize policies and regulations: through joint agreements on water allocation
- Potential to implement joint/transboundary integrated water resources projects: In Abbay Blue Nile, Rahad- Dinder, Tekeze- Atbara and Baro Akobo sub basins,

2.2.2.2.2 Rainfed sub-sector

OVERVIEW

With the exception of Egypt, rainfed agriculture plays an important role in supporting food security and overall economic growth in each of the EN sub-basins. A large area is cultivated under rain fed conditions and supports the lives and livelihoods of the large majority of the population. There is also huge potential for the expansion of rainfed agriculture in some parts of these countries. However, the subsector is underdeveloped and its contribution to the national economies is not as it could be. It is largely dominated by a subsistence mode of production and suffers from a number of limitations including:

- Use of extremely outdated agricultural technologies,
- Inadequate or weak research and extension services and credit facilities to farmers,
- Lack of improved seed varieties and agricultural packages,
- Poor and inadequate infrastructure; transportation, storage and processing facilities,
- Weak markets and non-existent market information systems.
- Unclear and fragmented land tenure system,
- Drought and flooding, particularly in the lowland areas.

The importance of projects/interventions targeted towards alleviating these constraints/limitations is often forgotten in the regional context and in the context of a project by project approach. It is essential that these interventions for an integral part of the multi-sectoral investment programme.

ONGOING AND POTENTIAL INTERVENTIONS

Ongoing and potential interventions in the rainfed sector are driven at the national level. However, it is clear that a much more productive and sustainable rainfed sector is of regional significance and there is therefore likely to be a place in the MSIOA for interventions related to this sub-sector.

- Research (improved crops varieties, modernisation of technologies and farming practices etc)
- Improved enabling environment (access to credit, insurance, transport, markets, storage and processing …
- Capacity building
- As a component of livelihood-based integrated watershed management programmes, aimed at reversing land degradation and at the same time promoting improved farming and land-use practices

2.2.2.2.3 Irrigation sub-sector

OVERVIEW

Irrigation development is a priority in all the Eastern Nile countries and is considered as an effective vehicle to mitigate the impact of climatic conditions and enhancing rural development and food security. There is approximately 6.7 million ha currently under irrigation in the region with additional 4 million ha potentially suitable for further

expansion. Although, production levels in Egypt are relatively higher, the overall performance of the existing irrigation schemes in the region generally is unsatisfactory.

Key challenges in the irrigation sub-sector include:

- Critical shortage of water for irrigation expansion and other competitive users,
- The prominent presence of ambitious and **unilateral plans** for irrigation expansion by all countries,
- Underdeveloped irrigation, drainage and agricultural technologies, which have resulted in very **poor water use efficiency** (wastage) and low productivity,
- **Lack of capacity** of institutes; little involvement of the end users (Water Users Associations) and the private sector in operation, maintenance and management of irrigation and drainage schemes,

However, there are also **significant opportunities**

- Potential to increase water availability/reduce evaporation losses: through **cooperative upstream water conservation/regulation projects**,
- Potential to save evaporation losses through **improved management** of the existing reservoirs,
- Potential to develop **coordinated regional irrigation expansion** planning: through NBI/ENTRO,
- Potential to increase water use efficiency and productivity: through **rehabilitation and modernization** of existing irrigation schemes, use of improved agricultural technologies, management transfer to the end users (Water Users Associations)…

ONGOING AND POTENTIAL INTERVENTIONS

Ongoing and potential interventions include both "hard" investment projects, that is investments which lead directly to infrastructure on the ground, and "soft" projects. Soft projects are those which are largely non-infrastructural but which would support the efficient management and performance of hard investment projects.

Proposed hard and soft investment projects/interventions that would be able to address some of the above challenges and opportunities in a foreseeable future could include:

- Capacity Building in the irrigation sector
- Improving the Performance of the existing Irrigation Schemes through hard and soft measures (rehabilitation, modernisation, improved control and scheduling etc)
- Studies for Integrated Transboundary Water Resources Development and Management at the sub-basin level
- Implementation of climate forecasting systems, information management systems for better water management
- Regional/transboundary approach to crop choices and food security
- Development of new irrigation schemes

2.2.2.3 Livestock Sub-sector

OVERVIEW

Livestock is a critical subsistence and economic activity in all the EN countries, the region being home for the largest livestock population in Africa. It is a major means of livelihood especially for pastoralists and agro-pastoralists living in the semi-arid areas of Ethiopia, Sudan and South Sudan. Livestock potential in the region has not yet been fully exploited due to a number of constraints, which among others include:

- Technical constraints including genetic limitations for production, inadequate and poor quality of feed resources, shortage of drinking water supply,
- Institutional constraints including poor linkages between research, extension and technology users, inadequate extension and training services, unreliable market and lack of access to credit. Inadequate research.
- Limited and periodic access to appropriate animal health services, heavy reliance on the public sector for animal health services, poor facilities for health services
- Socio-economic constraints including poor availability of adequate grazing land due to shrinkage and degradation of rangelands, recurrent drought and inter-sectoral conflict in some areas. Insufficient forage during the dry season and reluctance of pastoralists to commercialize cattle because of social importance and lack of alternative assets
- Lack of markets, processing facilities and inadequate transport/logistics,
- Absence of clear strategic policies and legislation aimed at supporting and promoting the sub-sector,
- Limited involvement of the commercial sector

ONGOING AND POTENTIAL INTERVENTIONS

The importance of projects/interventions targeted towards alleviating these constraints/limitations is often forgotten in the regional context and in the context of a project by project approach. **It is essential that these interventions for an integral part of the multi-sectoral investment programme**. Specific interventions will be generally driven at the national level but there are opportunities for transboundary cooperation in some sub-basins. In addition to actions aimed directly at tackling the above-mentioned challenges there are other projects which may have some significance at the level of the MSIOA including:

- Inclusion of the sub-sector in multipurpose projects
- As a component of livelihood-based integrated watershed management programmes, aimed at reversing land degradation and at the same time promoting improved farming and land-use practices

2.2.2.4 Energy and hydropower

OVERVIEW

As summarised in Table 2-1, demand at both the regional and national levels is growing rapidly, at a much faster rate than the population or economic growth rates. As far as the current situation is concerned, only in Egypt is the installed generating capacity greater than the peak demand, and here only by a small margin.

Table 2-1: Current and forecasted generation and peak demand requirements in all four countries

	Generation (GWh)					Peak demand (MW)					Annual growth (%)			
	Egypt	Ethiopia	Sudan	South Sudan	TOTAL	Egypt	Ethiopia	Sudan	South Sudan	TOTAL	Egypt	Ethiopia	Sudan	South Sudan
2012	164,628	7,869	12,737		185,234	25,000	1,398	1,853	33	28,284				
2015	196,334	14,688	14,662	474	226,158	31,880	2,956	2,947	80	37,863	5.5	4	19	53
2020	260,589	35,062	24,496	1,868	322,015	41,874	7,474	5,087	300	54,735	6.2	30	14.5	55
2025	342,626	53,209	33,448	3,173	432,456	54,402	12,636	6,613	500	74,151	6	13.8	6	13.3
2030	446,301	73,944	40,990	4,274	565,509	69,909	17,868	7,979	712	96,468	5.7	8.2	4	8.5
2035	575,478	89,047	47,381	5,479	717,385	88,947	23,556	9,476	1,033	123,012	5.4	6.3	4.8	10
2039	666,846	120,740	53,878	6,348	847,812	109,230	25,761	11,000	1,200	147,191	5.7	6	4	5

Regional demand can only be met by increasing capacity and by the sharing of capacity via an expanded interconnection. These two areas will be a central part of the multi-sectoral investment plan.

There is considerable hydropower potential in the basin, in particular in the Ethiopian highlands which form part of all three upstream sub-basins. In particular, the hydropower potential of the Abbay River is recognised as being of regional importance and has been studied in some detail. Construction of the downstream most of a cascade of dams on the Abbay River, the Grand Ethiopian Renaissance Dam (GERD), with a proposed installed capacity of 6000 MW, is well advanced.

ONGOING AND POTENTIAL INTERVENTIONS

Hydropower projects

The main opportunity for expansion of hydropower expansion is through:

- Implementation of identified and planned hydropower projects in each of the sub-basins
- Implementation of modified or new projects on the Blue Nile and Main Nile making use of regulated flows downstream of the GERD.

The existing and planned hydropower projects were reviewed as part of the Situational Analysis and are detailed by sub-basin in that document.

Interconnection projects

The development of interconnection projects is a critical component of regional cooperation the management and development of water resources. As already indicated, there is a shortage of electricity basinwide and there is an opportunity to share the electricity generated in Ethiopia (in particular) with the other riparian countries (and further afield).

Existing and potential interconnection projects have been detailed in the Situational Analysis.

2.2.2.5 Fisheries

OVERVIEW

Ethiopia, South Sudan and Sudan are landlocked countries and thus fisheries are entirely dependent on fresh inland water bodies (lakes, reservoirs and rivers. In Ethiopia, Lake Tana is the largest source of fish and this is supplemented by limited fisheries on lakes constructed for hydropower and irrigation. In South Sudan fisheries play a more important role about 14 % of households in South Sudan, particularly those in the Sudd and Machar area and along the River Nile and its tributaries, are engaged in fishery as a source of livelihood. In Sudan and Egypt inland fisheries represent a significant part of economic activity. In Sudan there are major fishing activities on the reservoirs behind the Roseires, Sennar and Marowe Dams on the Blue Nile, the Jebel Aulia Dam on the White Nile, and the Khashm al Girba Dam on the Atbara tributary of the main Nile and from Lake Nubia. In Egypt inland fisheries are focussed on the Aswan Lake.

There is a huge potential for aquaculture, especially in Ethiopia and South Sudan. Opportunities in Sudan as part of irrigation operation and development are also significant. Aquaculture in the Egyptian portion of the basin is well developed with a targeted harvest of 1 million tons from aquaculture alone, by year 2017.

- Lack of commercialised approach to aquaculture,
- Lack of trained personnel and experience in modernised fishing,
- Lack of fishing equipment and vessels,
- High post-harvest losses resulting from improper handling at source and during distribution,
- Lack of adequate research, technology and extension services;
- Lack of support infrastructure such as access roads, landing and onshore processing facilities, cold storage

ONGONG AND POTENTIAL INTERVENTIONS

Given the land-pressures associated with agriculture and livestock farming, development of aquaculture represents a major opportunity for the production of protein and the improvement of food security in the region. In addition to actions aimed directly at tackling the above-mentioned challenges there are other projects which may have some significance at the level of the MSIOA including:

- Inclusion of the sub-sector in multipurpose projects (reservoirs, irrigation schemes, conservation programmes
- As a component of livelihood-based integrated watershed management programmes, aimed at reversing land degradation and at the same time promoting improved farming and land-use practices

2.2.2.6 Natural Resources and the Environment

OVERVIEW

The environmental findings from the situational analysis report have concluded that soil erosion, land degradation, sedimentation, extreme floods, deforestation, desertification, sand dunes movement, water quality and pollution, agrochemicals and conservation of sensitive ecosystems are among the hot environmental issues that characterize Eastern Nile Basin and need to be carefully considered and addressed at the different development stages for each of the four sub-basins.

Environmental Risks Associated with Hydropower and Irrigation Developments

These include the following:

- Increased soil/land degradation due to excessive use of land for mechanized agriculture activities.
- Loss of forests and natural vegetation due to the creation of new reservoirs and agriculture lands.
- Loss of habitats and biodiversity due to the creation of new reservoirs and agricultural lands
- Loss of protected areas and wetlands
- Water pollution risk emerging with the use of agrochemicals and agricultural inputs.
- Water pollution risk associated with the construction and operation activities of the new developments
- Increased water salinity risk
- Potential Eutrophication risk with the creation of new reservoirs and submergence of massive quantities of biomass, thus affecting the aquatic life downstream
- Air pollution risk due to construction and operation activities
- Increased prevalence of water born and water related diseases
- Increase in spread of invasive alien species (hyacinth, etc.)

Environmental Opportunities associated with Hydropower and Irrigation Developments

These include:

- Optimized operation policies would result in a sustainable and constant river flow to meet the downstream riparian and environmental requirements
- Reduced risks of extreme floods and climate change impacts due to the controlled water flow
- Reduced river and bank erosion due to controlled water and sediment flushing.
- Reduced sedimentation problems downstream and within the irrigation systems.
- Reduced pressure on forest wood with the availability of new hydropower energy; specially when extended to rural areas
- Reduced greenhouse emissions and air pollution by introducing new hydropower plants as clean energy sources; thus reduced climate change impacts
- Protection of water bodies from pollution as a result of implementing proper water quality monitoring programmes
- Conservation of wetlands, protected areas and national parks when considered in the early stages of planning and development
- Allocation of new forest areas with the new irrigation schemes.
- Creation of new habitats ; specially for aquatic species
- Creation of new landing/resting grounds for migratory species
- Creation of new migratory routes for wildlife and livestock when considered in the planning and development stages

ONGOING AND POTENTIAL INTERVENTIONS

The early consideration of the environmental aspects at such strategic regional planning level (MSIOA) will reduce the eventual associated mitigation costs. The Multi-sectoral/ Integrated Planning approach is the best way to cater for environmental issues and minimize the adverse impacts. However, detailed ESIA, EMP, RAP are necessary to proceed with the proposed developments at the national or regional levels? The following can be considered as critical areas for intervention required to maintain the minimum environmental situation in the EN region:

- Environmental Management Plans are needed for wetlands and protected areas
- Demarcation of National Parks is very important in order to clearly define the limits for surrounding developments.
- Continuation and expansion of Integrated Watershed Management Projects is essential to combat the problem of soil and land erosion and at the same time to improve and make sustainable the livelihoods of farmers
- Afforestation and greenbelts programmes are important for the proper resistance of sand dunes movement
- Enhancement of the WASH sector around the sub-basins at the regional Level will reduce pressure on water resources and prevent pollution.
- Establishment of Regional Water Quality Monitoring Programmes to minimize pollution and its associated adverse impacts on human health and aquatic life.
- Awareness and capacity building programmes for the different stakeholders are also critical for the success of each project.

2.2.2.7 General and cross-sectoral interventions

In addition to the cross-sectoral interventions that can arise from the implementation of multipurpose projects, there are other **general and cross-sectoral interventions** which merit consideration for inclusion in the MSIOA body of interventions.

These include a number of possible transboundary projects for investment in the EN that offer opportunities for augmentation and increased reliability of water supply, socio economic development, environmental protection, reducing investment costs and above all enhancement of regional integration and cooperation. These are generally win-win or "no regret" type interventions with significant regional benefits and include livelihood-based integrated watershed management programmes, water demand management interventions (in all sectors), improved water resources (including surface water, ground water and climate) and water consumption monitoring

2.3 WATER RESOURCES BASELINE

2.3.1 Introduction

The water resources baseline has been established through the application of the *preliminary analytical framework. This was based on "the Annual Water Balance and Economic Assessment Tool",* which was custom-built in MS Excel for the MSIOA study. Only a brief introduction to this tool and framework is provided in this report. A more complete description can be found in the MSIOA-Task3 report and in Annex 1 of this report.

The current sectoral levels of demand (not including projects under construction) have been used as inputs for establishment of the water resources baseline, and can, be summarised as follows:

- **Irrigation:** The current situation for irrigation developed in the EN countries is summarised in Table 2-2.

Table 2-2: Current situation (CS) for irrigation in the NEL region

Sub-basin	Current situation (CS) in the EN region (1000 ha)
Abbay-Blue Nile	972
Bar-Akobo-Sobat	218
Tekeze-Setit-Atbara	219
Main Nile	5 334
TOTAL	**6 743**

- **Hydropower:** The current situation for hydropower developed in the EN countries is summarised in Table 2 3.

Table 2-3: Current situation (CS) for hydropower in the NEL region

Sub-basin	Current situation (CS) in the EN region (MW generating capacity)
Abbay-Blue Nile	1 867
Baro-Akobo-Sobat	30
Tekeze-Setit-Atbara	318
Main Nile	4 112
TOTAL	**6 327**

- **Water Supply**: The development levels related to water supply are taken into account only in terms of water demand. Where data are not available the dependant population has been used to calculate the water demand. The current situation (CS) corresponds to the water needs are those related to the current population within the basin, Domestic water supply at each water abstraction node is added to livestock and irrigation water supply.
- **Livestock:** Livestock watering requirements are related to current livestock numbers.
- The impact of ongoing **watershed management** activities are not assessed in the current version of the model. Improved condition of the watershed will lead to reduced sedimentation of reservoirs and reduced costs for water treatment works. Increases base flows can also be anticipated and reduced flood peaks. However, it is considered that anticipated benefits associated with watershed management activities are still lagging behind ongoing degradation
- Development levels related to **fisheries** is considered only as it relates to fishing activities in the main reservoirs. Aquaculture is not taken into account in the water resources modelling since volumes of water required are small.

- **Environmental Flows** are not specified during the scoping phase. The aim during the scoping phase is rather to look at the impact of different levels of development on minimum flows at key points.

2.3.2 Current water balance by Sub-basin

2.3.2.1 Introduction

The annual water balance has been calculated for key points in each of the sub-basin. This is a mean annual water balance based on a hydrological runoff series of 100 years in length, naturalised to take into account the impact of water resources developments during the period of record.

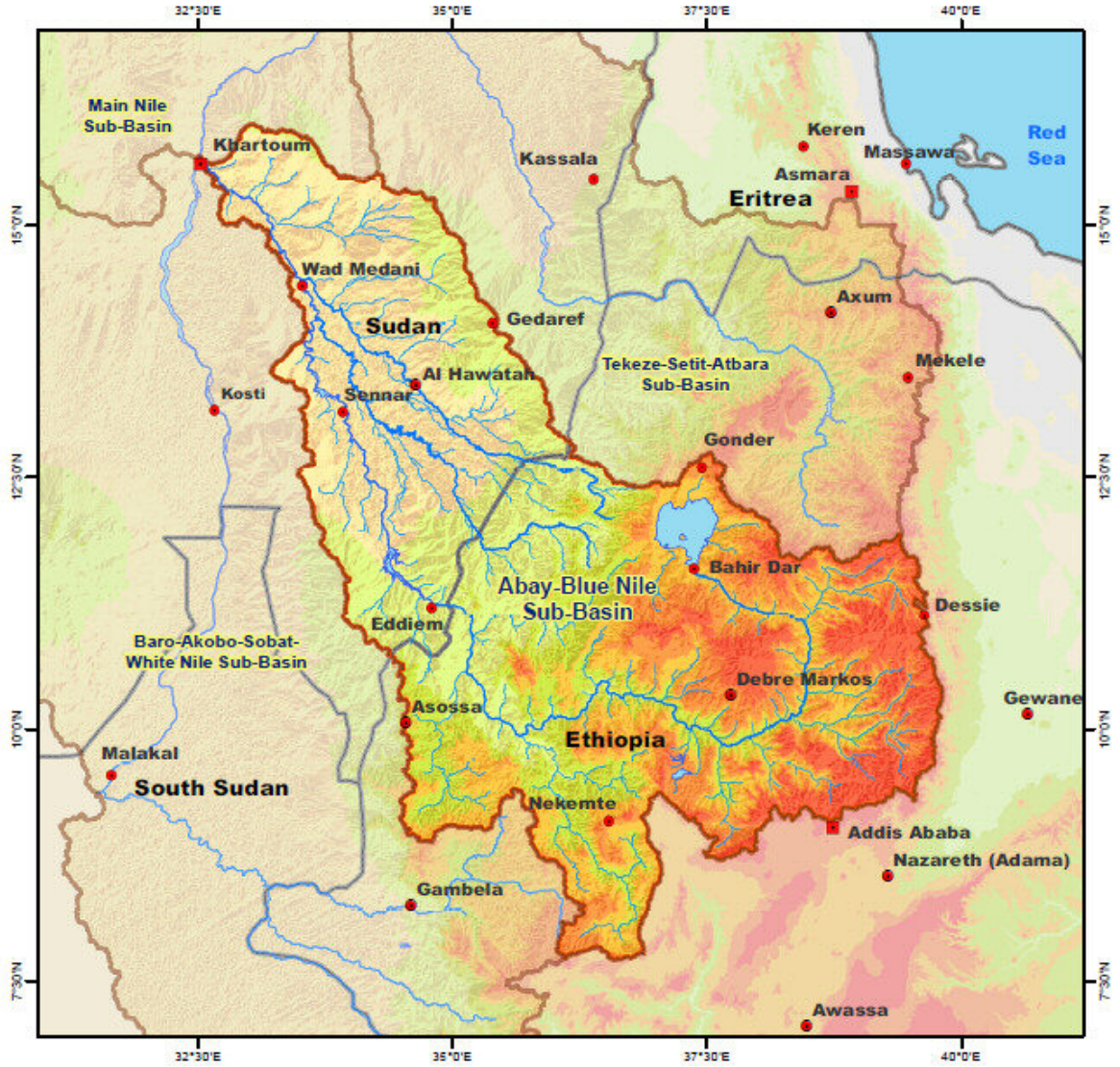


Figure 2-1: Abbay-Blue Nile Sub-Basin: Relief & Drainage

2.3.2.2 *Abbay – Blue Nile Sub-basin*

Flows into the Abbay River are regulated by the Chara Chara weir at the outlet of Lake Tana. This corresponds to the first point for the water balance of the sub-basin. Flows at other key points are summarised in Table 2-4.

Table 2-4 : Mean annual runoff and other water resource parameters at key point in the Abbay-blue Nile Sub-basin

Location / Parameter	Annual volume (1000xMm^3)
Lake Tana outflow	4.079
Abbay upstream of Mandaya	26.260
Abbay at Ethiopia/Sudan border (Diem)	49.674
Blue Nile downstream of Sennar Dam	41.017
Blue Nile at Khartoum	43.661
Mean annual evaporation from lakes and wetlands	2.179
Reservoir storage including Lake Tana	39.16

Flow crossing the Ethiopian border is estimated at just under 50,000 Mm^3. By the time the Blue Nile makes its confluence with the White Nile in Khartoum this has reduced by just over 6,000 Mm^3 to around 43,661 Mm^3.

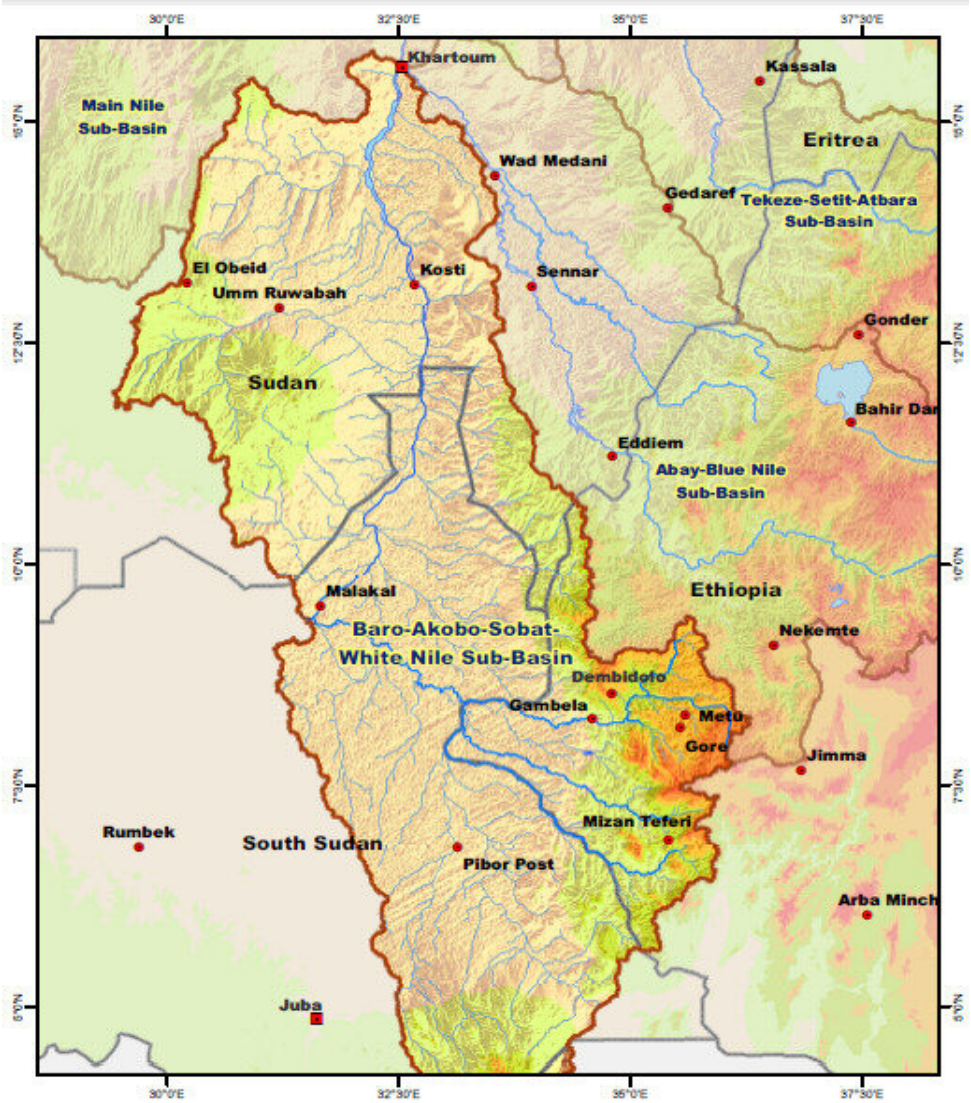


Figure 2-2: Baro – Akobo – Sobat White Nile Sub-Basin: Relief & Drainage

2.3.2.3 Baro-Akobo-Sobat White Nile Sub-basin

The largest tributary of the system is the Baro River, which rises in the Ethiopian highlands. In its lower reaches a large amount of water spills into the Machar swamp, significantly reducing the flow that reaches the confluence with the Sobat. The Sobat receives further contributions from the Gilo and Pibor/Akobo Rivers so that the mean annual runoff currently entering the White Nile is more than 13, 000 Mm^3.

Flows at other key points are summarised in Table 2-5.

Table 2-5 : Mean annual runoff and other water resource parameters at key points in the Baro-Akobo-Sobat White Nile Sub-basin

Location / Parameter	Annual volume (1000xMm^3)
Baro at Gambella	12.139
Baro u/s of Machar Wetlands	12.878
Machar Spill	3.541
Baro at confluence with Sobat	9.341
Akobo upstream of Twalor wetlands	5.560
Twalor Spill	2.518
Akobo (Pibor) at confluence with Baro/Sobat	3.634
Sobat upstream of White Nile confluence	13.328
White Nile downstream of Sobat confluence	30.290
White Nile at Khartoum	26.677
Mean annual evaporation from lakes and wetlands	1.950
Reservoir storage	4.610

Flow in the White Nile downstream of its confluence with the Sobat River is estimated at 32,290Mm^3. At its confluence with the Blue Nile in Khartoum, flow in the White Nile has reduced to 26,677 Mm^3.

Figure 2-3: Tekeze – Setit – Atbara Sub-Basin: Relief & Drainage

2.3.2.4 Tekeze – Setit – Atbara Sub-basin

The Tekeze (Setit in Sudan) River takes it source in the highlands of Ethiopia as the Goang (Atbara in Sudan) and Angereb Rivers. Flows are highly variable with very little retention in wetlands or floodplains anywhere in the basin. Sediment flows are very high.

Flows at other key points are summarised in Table 2-6.

Table 2-6 : Mean annual runoff and other water resource parameters at key points in the Tekeze – Setit – Atbara Sub-basin

Location / Parameter	Annual volume (1000xMm^3)
Tekeze Inflow to Tekeze Dam	3.755
Tekeze at Wad Hilew	7.715
Upper Atbara	3.766
Atbara upstream of Girba Dam	11.484
Atbara at confluence with main Nile	11.353
Mean annual evaporation from lakes and wetlands	0.427
Reservoir storage	0.155

Flow in the Atbara River at its confluence with the Main Nile is estimated at 11 353 Mm^3 and represents the last major input to the Nile on its way to the Mediterranean. Due to the limited extent of wetlands in the sub-basin and the low level of reservoir storage, total evaporation is small.

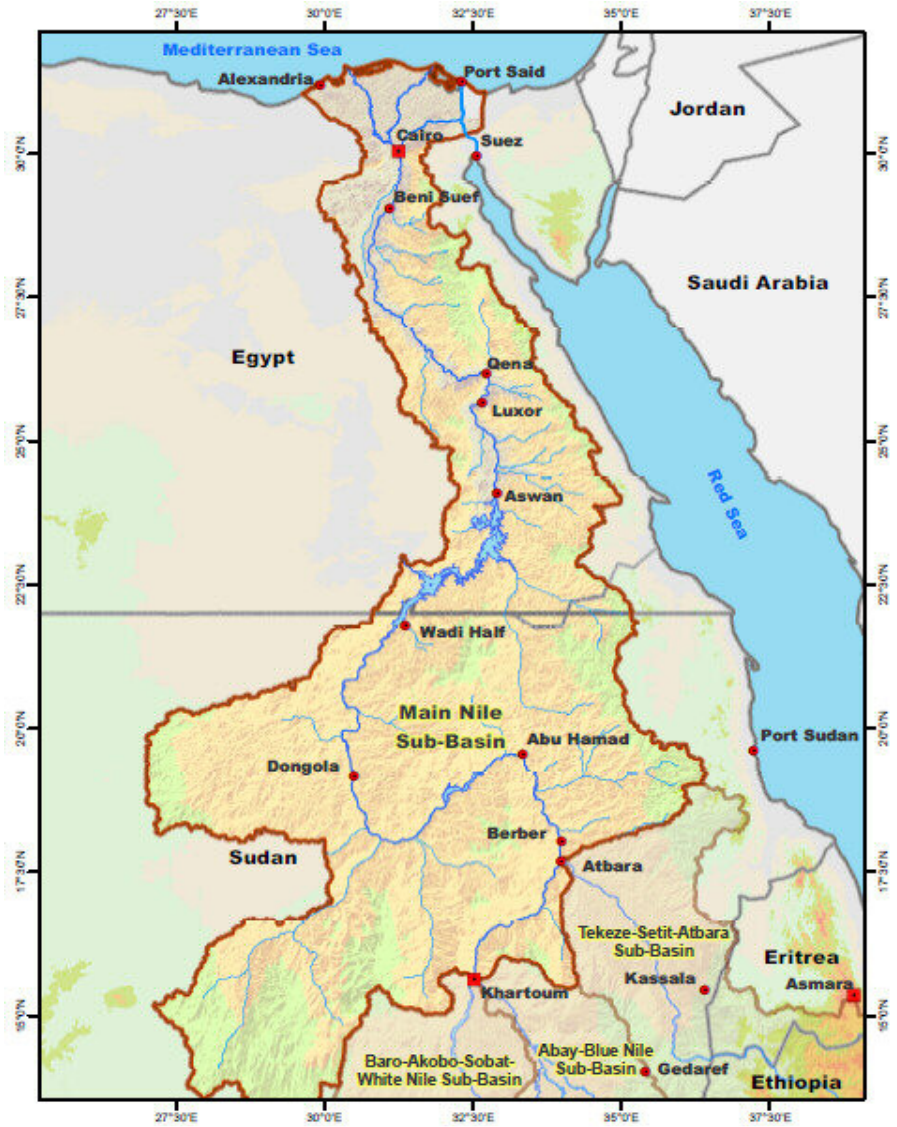


Figure 2-4: Main Nile Sub-Basin: Relief & Drainage

2.3.2.5 Main Nile Sub-basin

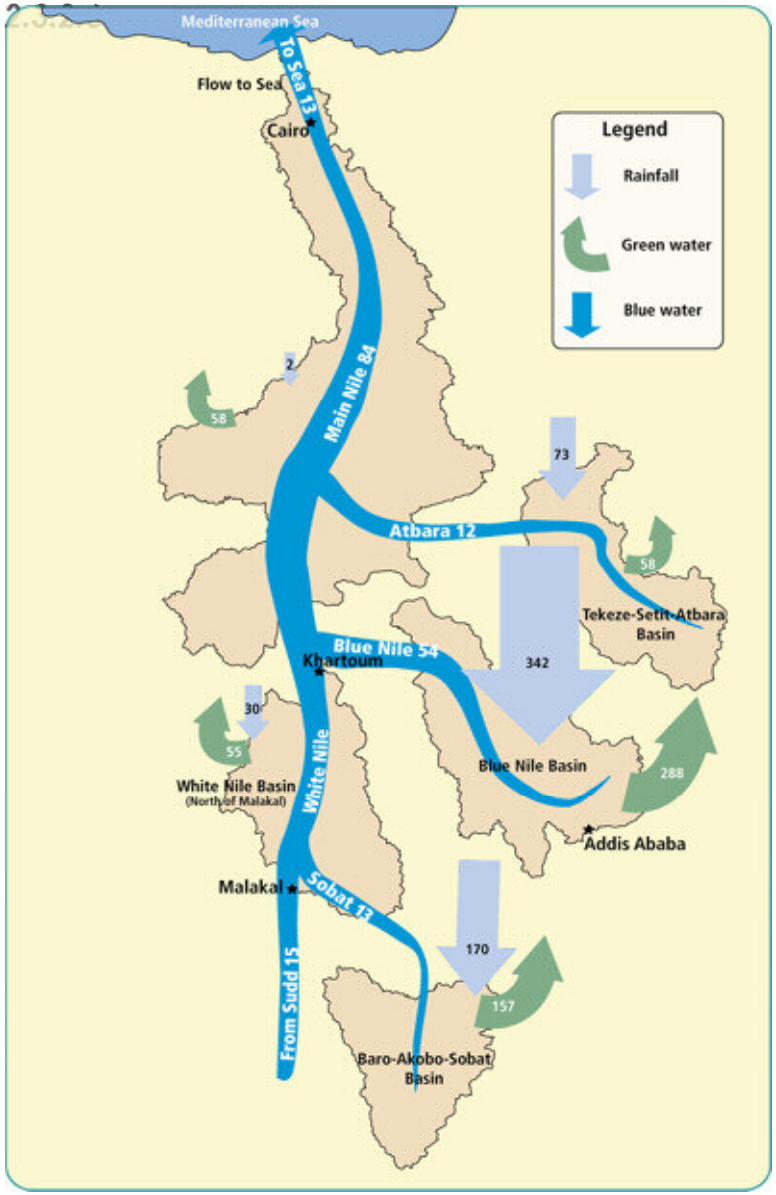
The Main Nile is formed by the White Nile and the Blue Nile at Khartoum, with the Blue Nile contributing around 62% (taking into account current levels of abstraction upstream). The only significant tributary adding ti the flow in the Main Nile further downstream is the Tekeze River which increases the flow by around 15%, meaning that the mean annual runoff of the Main Nile reaches its maximum just downstream of its confluence with the Tekeze River.

Flows at other key points are summarised in Table 2-6.

Table 2-7 : Mean annual runoff and other water resource parameters at key points in the Main Nile Sub-basin

Location / Parameter	Annual volume (1000xMm^3)
Nile d/s of BN and WN confluence	70.338
Nile u/s of Atbara	69.714
Nile d/s of Atbara	81.067
Nile u/s of Aswan Dam	78.501
Nile d/s of Aswan Dam	63.651
Nile at Baladela	43.088
Nile Outflow to Mediterranean	12.573
Mean annual evaporation from all lakes and wetlands	15.270
Mean annual evaporation from Aswan Dam	13.318
Reservoir storage	181.870

Abstraction upstream of Lake Aswan is limited but a combination of evaporation from the Aswan Lake and large-scale abstraction for irrigation reduces the flow in the river to such an extent that only around 12 500 Mm^3 reach the Mediterranean Sea.



2.3.2.7 *Current water balance - basinwide*

Bringing the fours sub-basins together, and using rounded numbers Figure 2-5 is presented to provide an overall perspective on the hydrological cycle in each sub-basin and the water balance of the entire Eastern Nile basin in terms of the "green water" used productively, infiltrated and evaporated and "blue water" that ends up in rivers. As shown, the three upper sub-basins all have much more rainfall and surface water outflows than are experienced downstream in Sudan and Egypt. Very little of the water supply in Egypt comes from rainfall; the vast majority originates from surface water flows from Sudan.

Evapotranspiration outflows in Egypt (includes crop water use, evaporation losses from reservoirs, and other system evaporation losses) amount to about more than 60 billion m^3 annually with just over 12 billion m^3 flowing into the sea.

Southward and upstream, rainfall in sub-basins within Sudan plays a greater role but is still only about 30% of total inflows. Evapotranspiration is about equal to surface water (outflows). In all three of the Ethiopian sub-basins the hydrology is dominated by rainfall. However, evapotranspiration losses still far exceed surface water outflows. Of about 580 billion m^3 of rainfall in Ethiopia annually, only about 14% makes it to a surface watercourse that flows to South Sudan or Sudan.

Figure 2-5: Overall Water Balance of the Eastern Nile showing Rainfall, green and blue waters

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3. Scoping of Investments

3.1 INTRODUCTION

As part of the Situational analysis ongoing and potential (including planned) interventions were identified on a sectoral and cross-sectoral basis. Not all of the smaller local and national projects were included, with the focus being on those that may be relevant for the MSIOA. These were then assessed against some simple criteria to see if they could qualify for eventual inclusion in the MSIOA. This process is referred to as the *Scoping of Investments.*

3.2 TYPES OF INVESTMENTS

Investments in water resources management and development may take many forms. Because of the prominent position that the analytical framework (see Annex 1) has in the MSIOA process, the assessment of projects tends to be unduly focused on infrastructure projects and especially the expansion of irrigation and hydropower. While these are the two biggest users of water in the basin and are sometimes in competition with each other, it is important to note that there are other critical interventions that must be taken into consideration.

Interventions may be:

a) Infrastructure water resources development projects, mainly (hydro)power, irrigation and water supply/sanitation

b) General (cross-sectoral, enabling and/or not location-specific)

c) (Water) resource management (rather than development) and generally non-infrastructural

d) Multipurpose in nature. Multipurpose projects may be infrastructure focussed (for example a reservoir serving hydropower, irrigation, water supply, fisheries etc) or a combination of a), b) and c).

For all of the above interventions may be transboundary (cross-border and/or involving more than one sub-basin) and/or national.

It is important to note that an intervention may be transboundary through consideration of benefits and/or impacts. In some case the transboundary interventions could be transboundary in terms of their siting (dam on a border river, transboundary parks etc).

While the focus in the scoping on projects and in the analytical framework (next step has been on "hard" development projects, it is essential that (water) resources and enabling (capacity building, data collection etc) projects (soft projects) are also identified in the MSIOA Implementation Strategy and Action Plan

3.3 SCOPING – SELECTION CRITERIA

3.3.1 Introduction

The various interventions identified as part of the Situational analysis have been evaluated against a set of criteria in order to decide which should be taken forward to the next step(s).

These criteria are presented and summarized in the following sub-sections:

3.3.2 Alignment with Key Policies, Plans and Programmes

The objective of the MSIOA project is to identify potential investment opportunities that create the opportunity for regional benefits and cooperation between the EN Basin countries. The identification of potential investment opportunities should therefore be consistent with the broad objectives and outcomes outlined in the Nile Basin Sustainability Framework (NBSF) and the key principles that underpin the NBI Environmental and Social Policy (ESP). Projects that do not meet these objectives of the NBSF and or support the key principles that underpin the ESP are unlikely to achieve the shared vision of the NBI. It is therefore critical that each of the projects be tested against their ability to contribute towards achieving the broad objectives and outcomes outlined in the NBSF and the policies of the ESP. The broad objectives, desired outcomes and principles set out in the NBSF and ESP therefore provide the MSIOA study with a high level, strategic checklist for identify and evaluating potential investment options in the EN Basin. The key goals, objectives and principles are listed below.

NILE BASIN SUSTAINABILITY FRAMEWORK (NBSF)

As indicated above, the desire of the Nile riparian states to jointly develop and manage the common Nile water resources to fight poverty, catalyse economic development and regional integration, build a solid foundation of trust and confidence, and promote stability in the region is proclaimed in their Shared Vision:

"To achieve sustainable socio-economic development through equitable utilization of, and benefit from, the common Nile Basin water resources."

The objectives and outcomes are summarised below.

- **Broad Objectives**
  - To facilitate and contribute to socio-economic development, poverty reduction and improvement of livelihoods of riparian communities through equitable utilisation and sustainable development of the common Nile basin water resources;
  - To facilitate and contribute to efficient management of the Nile water resources drawing on principles of integrated water resources management (IWRM), and good practices in trans-boundary water resources management;
  - To facilitate and contribute to wise use of sustainable management of the environment and water-related natural resources of the Nile Basin;
  - To facilitate the main streaming of climatic change adaption and mitigation measures in the development and management of Nile water resources, and support Nile Basin countries in dealing with issues of climate variability and change.

  - To augment the efforts at achieving basin sustainability through facilitating selected cross-cutting activities that support the sustainable management and development of water and environmental resources of the Nile Basin.

- **Desired Outcomes**
  - Enhance social-economic development, reduced poverty and improved livelihoods for riparian communities from equitable utilisation and sustainable development of the common Nile Basin water resources.
  - Improved efficiency in the management and utilisation of the water resources achieved through the application of principles of integrated water resources management (IWRM) and good practices in trans-boundary water management.
  - Sustainable and well-managed watersheds, aquatic ecosystem and water-related natural resources of the Nile Basin.
  - Reduced impact of climate change and variability on water resources, aquatic ecosystems, water-related infrastructure, livelihoods of riparian communities, and the general social economic development of the basin.
  - Increased sustainability of NBI activities achieved through more effective communication, greater stakeholder participation, gender mainstreaming, capacity building and improved resource mobilisation.

NBI Environmental and Social Policy (2013)

- Key objectives:
  - Objective 1: To provide a set of principles and fields of action for the integration of environmental and social concerns in NBI programs;
  - Objective 2: To provide guidance for managing trans-boundary environmental and social impacts of national activities;
  - Objective 3: To provide support to Nile Basin countries for the protection and conservation of critical Nile Basin environmental resources;
  - Objective 4: To demonstrate commitment of the NBI and Nile countries to international best practices with regard to environmental and social management of development activities.
- Key Principles
  - Sustainable socio-economic development;
  - Basin-wide cooperation;
  - Subsidiarity principle;
  - Compatibility and complementarity;
  - Precautionary principle;
  - Public participation and consultation;
  - Accountability and transparency;
  - Social equality;
  - Gender equity.

The projects also need to be aligned with national policies, development strategies and master plans. This is a fundamental. The aim of the MSIOA is coordinate and build on opportunities for cooperation and synergy.

3.3.3 Regional Significance

The MSIOA is not aimed at defining national or local development paths. It is important that the action plan proposed in the final step of the study present actions that are of regional significance. This significance may be in terms of: Impacts such as

- a significant decrease in stream flows downstream
- change in the seasonality of flows effecting environmental issues such as biodiversity
- deteriorating water quality
- benefits such as
  - Improved water security
  - Flood control
  - Reduction in sediment load
  - A more regulated flow allowing hydropower and irrigation development
- Implementation mode Essentially this refers to projects which are actually sited in more than one country such as :
  - dams, reservoirs, diversion and abstraction works sited on shared border rivers.
  - Transboundary national parks

3.3.4 Socio-economic Opportunities and Impacts

The situational analysis identified and reviewed key socio-economic issues and challenges. A number of social "hotspots", where these issues and challenges are particularly evident, were also identified. Issues include:

- Poverty reduction (positive)
- Food and water security (positive)
- Infrastructure and economic development (positive)
- Energy security (positive)
- Employment and skills development opportunities (positive)
- Flood control (positive);
- Resettlement (negative);
- Impact on traditional livelihoods and cultures (negative)

Projects situated in social hotspot areas and which could address (or avoid the negative ones) were given preference

3.3.5 Environmental Opportunities and Impacts

These have been identified and assessed for a number but not all projects. The level of assessment and quality of baseline data also varies from project to project. The main environmental opportunities and impacts are listed in the Situational Analysis. While many of these issues are relevant for most parts of the basin, it was concluded that there are also environmental "hotspots" where these issues and challenges are particularly evident. These issues include:

- Loss of wetlands and impact on natural ecosystems (negative);
- Loss of biodiversity (negative)
- Impact on water quality (negative and positive)
- Conservation of areas of high biodiversity value (biodiversity offsets) (positive)
- Improved ecological flow (positive)
- Reduced siltation (positive);

- Reforestation and improved management of catchment areas (positive);
- Improved management of protected areas (positive):

3.3.6 Impact on Water Resources

While the issue of impact on water resources was relevant for some of the larger individual projects it was clear that the consideration of cumulative impact on water resources and water security is a key issue. (see Section 3.5). This area requires prominent consideration in the MSIOA given the already high level use of and dependence on surface water resources in many parts of the basin, especially in Egypt.

3.3.7 . Economic Viability and Equity

In terms of economic viability the identification of investment opportunities must include an assessment of individual project economic indicators such as NPV; IRR and benefit/cost ratio. Only projects which are economically viable should be considered. All other things equal, those with the best economic returns should be prioritised.

In addition the economic viability the issue of equity must also be considered. In this regard the identification of investment opportunities must assess if the project contribute to equity in benefit sharing at the transboundary and/or national level

3.4 APPLYING PROJECT-BASED CRITERIA

The criteria presented in Section 3.3 above were used to consider whether interventions should be taken forward to the next steps of the project.

For the infrastructure projects, essentially the irrigation expansion and hydropower projects, this means selection for inclusion in the different scenario options that will be analyzed in the next step of the study (Phase 3, Multi-Sectoral Analysis of Investment Opportunities).

For the non-infrastructure projects this means that qualifying interventions will be taken forward for inclusion in the MSIOA Investment Strategy and Action Plan unless the projects are contrary to the "preferred" scenarios as selected in the next step of the study, which is generally unlikely.

The interventions that are proposed for taking forward are presented in Section 3.6 of this report.

3.5 APPLYING CRITERIA WHICH REQUIRE CUMULATIVE CONSIDERATION

3.5.1 Introduction

While the application of individual project-based criteria will allow some projects to be retained and some to be rejected (or left for implementation according to national priorities alone), as already indicated, some of the evaluation criteria may not be significant at the project level and will, therefore, require the application of a catchment-wide (at sub-basin or all basin level) approach.

For example, when environmental Impacts are considered, including the effect on downstream flows (e.g. entering, leaving wetlands), it is clear that the study must

evaluate the cumulative impacts (positive and negative) associated with all of the projects as well as the issue of possible mutual exclusivity.

The terms of reference for the study require this to be done for the baseline (CS) (see Section 2.3). However, it has also been taken one step further as part of the scoping exercise through the use of exploratory **"scoping scenarios".**

These scoping scenarios are different from the actual development and management scenarios that will be investigated in the next step of the study, in that they do not attempt to look at how to best assess the trade-off between irrigation and hydropower, or irrigation and the environment, or what would be the optimum way of managing reservoirs. They also do not attempt to compare the relative merits of one set of irrigation schemes against another or of developing in one sub-basin compared to another. The scoping scenarios simply assume an expansion in both hydropower and irrigation by assuming the implementation of projects that have been identified in national master plans and similar studies. The scoping scenarios are aimed at providing the information that is required to make strategic development decisions at the sub-basin and basin-wide levels. These strategic decisions or orientations will help the study to design and fine-tune the best development and management scenarios at the project level in Phase 3 of the study (Multi-Sectoral Analysis of Investment Opportunities)

3.5.2 Methodology

3.5.2.1 Overview

The aim of the scoping or exploratory scenarios is to investigate the impact (at key points in the four sub-systems) of an incremental increase in water demand. This demand essentially comes from implementing different levels of hydropower and irrigation development together with the reservoirs that are associated with these developments.

By understanding the environmental and socio-economic implications of the proposed expansion trajectories, as defined by three future levels of development ("planned/under construction", large development (LD) and "full" development of potential (FP), it is be possible to test the limits of the system. This will assist in providing a realistic envelope of development space and strategic guidance towards the detailed planning of scenarios in Phase 3. of the study.

The impact of the different levels of development will be assessed through the use of a number of environmental/water resource and socio-economic indicators. The emphasis is placed on the environmental/water resources indicators since, as will become evident, the limiting factors for development are more dependent on the **availability of water** than the availability of economically viable development projects. Water availability is therefore the key limiting factor affecting the identification of potential projects in the EN Basin.

Environmental/water resource indicators that are reported for each of the scoping scenarios include:

- Flows at key points on main tributaries in each sub-system, including upstream and downstream of major wetlands
- Spills and outflows (means and minimums) from major wetlands in each sub-basin
- Evaporation from lakes, reservoirs and wetlands in each sub-basin
- Reservoir storage in each sub-basin

3.5.2.2 Preliminary Analytical framework

This framework, essentially the "Annual Water Balance and Economic Model", is outlined earlier in the report when it was used to describe the current water balance in the each of the sub-basins. The framework features are described in Annex 1. The same framework is used for this part of the analysis but instead of looking at the current/existing level of development, it is used to look at the impact of potential **future development.** The structural investments (mainly hydropower and irrigation investments) taken into account in the model are those already identified in the situational analysis report.

The economic component of the assessment is not discussed in this report since economic consideration beyond the basic socio-economic indicators is not relevant at the scoping level. This is only done in the next step when actual management and development scenarios are investigated as part of the MSIOA scenario analysis (Phase 3). .

3.5.3 Definition of the exploratory scoping scenarios

3.5.3.1 Overview

A key element of the situational analysis was the identification and description of existing and planned projects/interventions in each of the four sub-basins. Details are to be found in Chapter 5 of the Situational Analysis Report.

The **aim of the scoping scenarios is to investigate the impact (at key points in the four sub-systems) of an incremental increase in the water demand**. This demand essentially comes from an increase in the number of hydropower schemes and in the number of hectares irrigated, together with the reservoirs that are associated with these developments. Urban water supply is also taken onto account in the water distribution model, although abstraction quantities can be considered insignificant.

- **CS: *Current situation:*** current level of development, reference situation, already presented in Section 2.3 of this report.
- **IS: *Improved situation***: Irrigation modernization, rehabilitation of current irrigation schemes and schemes under implementations, such as those around lake Tana. Hydropower projects under construction such as GERD in Ethiopia and Upper Atbara (Rumela) in Sudan.
- **LD**: ***Large development***: all identified projects advanced either to pre-feasibility or feasibility level are considered in addition to the existing ones. The most advanced hydropower projects up to feasibility or pre-feasibility level (Karadobi, Beko-Abo, Baro 1&2, Kajbar) are added to the improved situation;
- **FP**: ***Full level of development of irrigation and hydropower.*** This is effectively all irrigation potential that is either identified as part of country master plan, ENIDS and potential identified under this study. All identified hydropower projects are considered in addition to the existing ones. This thus represents all the projects that have been envisages through largely unilateral planning by each country

It should be noted that the scoping scenarios are **cumulative in nature** in that all elements of the CS are included in IS, all of IS in LD and all of LD in FD.

Total levels of hydropower and irrigation development by sub-basin as implied by the scoping scenarios are summarised in Table 3-1.

Table 3-1: Levels of hydropower and irrigation implied by each scoping scenario

	Sub-basin	CS	IS	LD	FDP
Hydropower development (MW generating capacity)	Abbay-Blue Nile	1 867	7 082	8 682	11 867
	Bar-Akobo-Sobat	30	30	861	861
	Tekeze-Setit-Atbara	318	453	768	768
	Main Nile	4 112	4 112	5 012	5 412
Total		6 327	11 542	15 323	18 908
Irrigation development (ha)	Abbay-Blue Nile	972	1 006	1 627	2 397
	Bar-Akobo-Sobat	218	229	853	1 053
	Tekeze-Setit-Atbara	219	219	458	536
	Main Nile	5 333	5 349	5 426	5 432
Total		6 742	6 803	8 364	9 418

Environmental Flows are not specified during the scoping phase. The aim during the scoping phase is rather to look at the impact of different levels of development on minimum flows at key points.

The development levels related to **water supply** are taken into account only in terms of water demand. The growth of the various populations (urban and rural) has been estimated using national population growth rates.

Domestic water supply at each water abstraction node is added to livestock and irrigation water supply. The development levels related to **livestock** are only assessed in terms of opportunities related to growth in livestock associated with irrigated agriculture. The Livestock and feed water requirements are added to irrigation and domestic's water supply requirements at each node.

Further details of the four scoping scenarios, in particular as they relate to irrigation and hydropower are provided in Annex 1

3.5.3.2 Improved situation (IS)

The findings of the Situational Analysis indicate that the current area under cultivation in the current irrigation schemes is, in most cases, less than the total command area of the schemes. An example is the 'Gezira scheme' in Sudan where around 377, 00 ha are under cultivation today out of a scheme potential of 579,000 ha. The **assumption is made that, as a first step, the EN countries will develop irrigation so that current schemes are used according to their command areas.**

This implies that much of the IS scoping scenario will comprise rehabilitation of schemes and investment on irrigation modernization and efficient water uses as well as introducing new forms of technologies for increasing productivity and reducing cost of production. This includes investment in machinery, more efficient use of fertilizers, proper finance to farmers, crop diversification and liberalization including incentives for high crop returns such as perennial crops. In addition investment will focus on improving water management on these schemes and reducing losses as well as soft investment in Agriculture research to improve seed varieties and increase productivity.

The criteria for qualifying irrigable land under the improved situation is as follows:

- Any existing low performing scheme with feasibility potential for rehabilitation or irrigation modernization;

- The level of investment in rehabilitation or irrigation modernization shall not acquire supplementary storage infrastructures and the cost shall not exceed 30% of the current assets;
- All irrigation schemes that are currently under construction are categorized under improved situation as long as they are anticipated to be operation within 5-10 years.

The improved situation for the development of irrigated agriculture in the EN region therefore reflects a combination of the rehabilitation of current irrigation schemes plus the development of current schemes under construction. In terms of area the total under irrigation increases marginally from 6 742 ha (CS) to 6 803 ha (IS).

In terms of hydropower, the total installed capacity of all hydropower schemes in the EN basin increases from 6 327 MW (CS) to 11 542 MW (IS), largely due to the operationalization of GERD.

3.5.3.3 Large development (LD)

The findings of the Situational Analysis indicate that the population in the EN region is increasing rapidly and secondly that all of the EN countries suffer from food shortages which requires them to import food. These two issues could lead decision makers to increase agricultural production at a higher rate than witnessed in the past. The LD option therefore assumes an elevated rate of irrigation development.

The criteria for qualifying irrigable land under LD is as follows:

- Development of any potential irrigation scheme advanced to pre-feasibility or feasibility study level;
- All projects identified under country master plans or ENIDS diagnostic study and ranked as feasible with an EIRR of 10% and above.

In terms of area the total under irrigation increases to from 6 742 ha (CS) and 6 803 ha (IS) to 8 364 (ha) LD.

The total installed capacity of all hydropower schemes in the EN basin increases from 6 327 MW (CS) and 11 542 MW (IS) to 15 323 MW (LD).

3.5.3.4 Full Development of Potential (FP)

This option makes the assumption that all the estimated irrigation potential (in terms of identified projects) is converted into irrigated agriculture. .In terms of area the total under irrigation increases to 9 418 ha, compared to 6 742 ha (CS), 6 803 ha (IS) and 8 364 ha (LD). .

The total installed capacity of all hydropower schemes in the EN basin increases to 18 908 MW compared to 6 327 MW (CS), 11 542 MW (IS) and 15 323 MW (LD).

3.5.4 Results

3.5.4.1 Introduction

As indicated above, the purpose of the scoping scenarios is to **provide a straightforward and transparent basis for investigating the effect of "increasing the load"** on the system. Some simple indicators have been developed to provide an indication of the effect of development at key points in the system.

Both environmental/water resource and some basic socio-economic indicators are used.

Environmental/water resource indicators that are reported for each of the scoping scenarios include:

- Flows at key points on main tributaries in each sub-system, including upstream and downstream of major wetlands
- Spills and outflows (means and minimums) from major wetlands in each sub-basin
- Evaporation from lakes, reservoirs and wetlands in each sub-basin
- Reservoir storage in each sub-basin

Socio-economic indicators that are reported for each of the scoping scenarios include:

- Installed capacity (MW) in each sub-basin.
- Mean GWhrs/annum produced by hydropower in each sub-basin
- Hectares of irrigation in each basin
- Employment levels associated with water resources development
- Water consumption

The results of the analyses are summarised in Table 3-2 to Table 3-5. The results have been arranged so as to allow for an easy comparison between scoping scenarios.

3.5.4.2 Abbay-Blue Nile sub-basin

Table 3-2 provides an overview of the environmental and socio-economic indicators for scoping purposes under the four scoping scenarios for the Abbay-Blue Nile sub-basin.

Table 3-2: Environmental, social and economic indicators for the Abbay – Blue Nile Sub-basin

Parameter/ indicator		CS	IS	LD	FP
Environmental / water resource indicators		**Flow volume (1000 x Mm^3**			
Lake Tana outflow	Mean annual volume	4.079	3.865	3.625	3.224
Abbay u/s of Mandaya	Mean annual volume	26.260	26.046	25.158	24.549
Abbay at Ethiopia/Sudan border (Diem)	Mean annual volume	49.674	48.086	45.185	43.674
Blue Nile d/s of Sennar Dam	Mean annual volume	41.017	37.707	27.135	20.626
Blue Nile at Khartoum	Mean annual volume	43.661	40.546	29.484	21.746
		Reservoir storage (Mm^3/a) and Evaporation (Mm^3/a)			
Mean annual evaporation from lakes and wetlands	Total evaporation	2.179	3.634	3.961	5.001
Reservoir storage including Lake Tana	Mean annual storage	39.16	113.16	153.36	241.33
Socio-economic indicators		**Hydropower production, irrigation area and employment indicators**			
Hydropower	Total MW installed	1 082	7 082	8 682	11 867
	Average GWhrs/annum	5 428	21 689	30 816	58 429
Irrigation	Irrigation area (ha*1000)	972	1 006	1 627	2 397
	Total water supplied to irrigation (1000 x Mm^3/annum)	9.212	11.836	23.012	30.006
Employment (irrigation, livestock and fisheries)	1000s of people employed	4 151	5 215	12 275	15 965

Some of the key observations can be summarized as follows:

- The impact of growing irrigation around Lake Tana (and via transfer to Beles) is significant. The average storage of Lake Tana could decrease by nearly a quarter. It will be important to maintain minimum levels for **environmental reasons and to ensure that navigation is not impacted**.
- Implementing all potential irrigation and evaporation from new reservoirs in the Abbay sub-basin results in a decrease in the flow crossing the border with Sudan of around 6 billion m^3, reducing from the current volume of 49.674 billion m^3 to 43.674 billion m^3. The reduced flow will be highly regulated compared to the current situation and will have **generally positive impacts on hydropower further downstream and will support irrigation expansion without further regulation infrastructure. The establishment of large hydropower dams on the Abbay River will also significantly reduce sediment loads in the Blue and Main Nile, which in turn, will improve the efficiency of irrigation schemes and downstream hydropower schemes (current and future). The regulation of the flood regime will also reduce the impact and damage associated with the annual flood. The loss of the annual flood will however have a negative impact on traditional recession agriculture that is practiced along the banks of the Blue and Main Nile in Sudan.**

- The impact on flows in the Blue Nile of increasing the irrigated area in Sudan is significant. Implementation of all the identified projects as defined in the FP scoping scenario would see a decrease in the flow from over 40 billion m^3 to just over 20 billion m^3. This would have **some impact on hydropower generation further downstream and the availability of water for existing irrigation schemes**. **The significant reduction in the sediment loads will also improve efficiency of hydropower plants.**
- Total evaporation from the system will increase from the current 2.179 billion m^3, almost entirely from Lake Tana, to just over 5 billion m^3, the increase largely as a result of the GERD.
- The implementation of the GERD will see power production increase around 4 fold to over 20 000 GWhrs. However, once the cascade of hydropower dams are in place on the Abbay as reflected under the FDP, production will **increase to nearly 60,000 GWhrs.**

3.5.4.3 Baro-Akobo-Sobat White Nile Sub-basin

Table 3-3 provides an overview of the environmental and socio-economic indicators for scoping purposes under the four scoping scenarios for the Baro-Akobo-Sobat White Nile sub-basin.

Some of the key observations can be summarized as follows:

- Comparing the FDP scoping scenario with the current situation, the flow in the Baro (from which most of the irrigation water would be supplied) upstream of the Machar Marshes is reduced from the current 12.878 billion m^3 to 8.171 billion m^3, a decrease of 4.7 billion m^3. The impact on the Machar spill is that it is reduced from 3.541 to 1.215 billion m^3, a reduction of 2.3 billion m^3. **The impact of this on the ecology of the Machar Marshes and traditional livelihoods would have to be investigated**.
- As a result of the reduced evaporation from the Machar Marshes the flow of the Baro at its confluence with the Sobat is reduced by only 2. 4 billion Mm^3
- The situation for the Akobo is similar. Comparing the FP scoping scenario with the current situation, the flow in the Akobo upstream of the Twalor wetlands is reduced from the current 5.560 billion m^3 to 1.316 billion m^3, a decrease of 4.2 billion m^3. However, this would not stop spill into the Twalor, only reduce it from 2.518 to 0.576 billion m^3, a decrease of nearly 2 billion m^3. **The impact of this on the ecology of the Twalor wetlands and traditional livelihoods would have to be investigated**.
- Under full development conditions the flow of the Akobo at it confluence is reduced by 1.887 Mm^3 from 3.634 to 1.041 billion m^3.
- The impact of the full level of development on the flow of the Sobat as it enters the White Nile is a reduction from 13.328 to 7.374 billion m^3, nearly 6 billion m^3.
- Since **all of the hydropower projects are upstream of the proposed irrigation areas irrigation abstraction has no impact on hydropower generation** even in the full development scenario

Table 3-3: Environmental, social and economic indicators for the Baro-Akobo-Sobat- White Nile Sub-basin

Parameter/ indicator		CS	IS	LD	FP
Environmental / water resource indicators		**Flow volume (1000 x Mm3) at key points (see schematic in Annex 3)**			
Baro at Gambella	Mean annual volume	12.139	12.139	12.139	12.139
Baro u/s of Machar Wetlands	Mean annual volume	12.878	12.878	9.156	8.171
Machar Spill	Mean annual volume	3.541	3.541	1.702	1.215
Baro at confluence with Sobat	Mean annual volume	9.341	9.341	7.459	6.961
Akobo u/s of Twalor wetlands	Mean annual volume	5.560	5.560	2.454	1.316
Twalor Spill	Mean annual volume	2.518	2.518	1.097	0.576
Akobo at confluence with Baro/Sobat	Mean annual volume	3.634	3.521	1.702	1.041
Sobat u/s of White Nile confluence	Mean annual volume	13.328	13.215	8.929	7.374
White Nile d/s of Sobat confluence	Mean annual volume	30.290	30.176	25.890	24.335
White Nile at Khartoum	Mean annual volume	26.677	25.837	21.190	19.314
		Reservoir storage (1000 x Mm^3/a) and Evaporation (1000 x Mm^3/a)			
Mean annual evaporation from lakes and wetlands	Total evaporation	1.950	1.950	2.125	2.125
Reservoir storage including	Mean annual storage	4.61	4.62	13.77	13.77
Socio-economic indicators		**Hydropower production, irrigation area and employment indicators**			
Hydropower	Total MW installed	30	30	1 549	1 549
	Average GWhrs/annum	143	143	5 017	5 017
Irrigation	Irrigation area (ha*1000)	218	229	853	1 053
	Total water supplied to irrigation (billion m^3/annum)	2.026	2.567	10.321	13.204
Employment (irrigation, livestock and fisheries)	1000s of people employed	698	966	7 250	8 788

3.5.4.4 Tekeze-Setit-Atbara Sub-basin

Table 3-4 provides an overview of the environmental and socio-economic indicators for scoping purposes under the four scoping scenarios for the Tekeze-Setit-Atbara sub basin.

Some of the key observations can be summarized as follows:

- Comparing the FDP scoping scenario with the current situation, the flow leaving the Tekeze-Setit-Atbara sub-system is reduced by nearly 5 billion m^3 from 11.353 down to 6.397 billion m^3.
- The increase in evaporation losses between those under FP and the current situation, is small.

While hydropower and irrigation development possibilities are small compared to other sub-basins, there are opportunities for multipurpose reservoirs serving both hydropower and irrigation (and other sectors).

Table 3-4: Environmental, social and economic indicators for the Tekeze-Setit-Atbara Sub-basin

Parameter/ indicator		CS	IS	LD	AP
Environmental / water resource indicators		**Flow volume (1000 x Mm3) at key points (see schematic in Annex 3)**			
Tekeze Inflow to Tekeze Dam	Mean annual volume	3.755	3.755	3.755	3.755
Tekeze at Wad Hilew	Mean annual volume	7.715	7.715	7.074	6.200
Upper Atbara	Mean annual volume	3.766	3.766	3.483	3.483
Atbara u/s of Girba Dam	Mean annual volume	11.484	11.484	8.510	7.414
Atbara at confluence with main Nile	Mean annual volume	11.353	11.032	7.837	6.397
		Reservoir storage (Mm^3/a) and Evaporation (Mm^3/a)			
Mean annual evaporation from lakes and wetlands	Total evaporation	0.427	0.427	0.654	0.654
Reservoir storage including	Mean annual storage	155	155	394	394
Socio-economic indicators		**Hydropower production, irrigation area and employment indicators**			
Hydropower	Total MW installed	318	453	1 088	1 088
	Average GWhrs/annum	1 017	1 181	2 034	2 034
Irrigation	Irrigation area (ha*1000)	218	218	457	535
	Total water supplied to irrigation (Billion m^3/annum)	1.966	2.287	5.256	6.695
Employment (irrigation, livestock and fisheries)	1000s of people employed	1 455	1 455	3 055	3 903

3.5.4.5 Main Nile Sub-basin

Table 3-5 provides an overview of the environmental and socio-economic indicators for scoping purposes under the 4 scoping scenarios.

Some of the key observations can be summarized as follows:

- Even under the current situation only 12.5 billion m^3 of the 70.3 billion m^3 (despite increasing to more than 80 billion m^3 after inflow from the Atbara River) of water entering the Main Nile reaches the Mediterranean Sea. The majority of the 70 billion m^3 is consumed by irrigation, although **more than 13 billion m^3 is lost to evaporation** from the Aswan Dam.
- Minimal expansion of irrigation in Egypt has been assumed since the impact of upstream development will already be significant.
- Implementation of the improved situation will reduce outflow to the Mediterranean Sea by 2.5 billion m^3. The increased regulation of the Blue Nile will, however, result in a small increase in hydropower production in the Main Nile. The reduction in the sediment loads will also extend the lifespan of the High Aswan Dam.
- Under current levels of abstraction from the Main Nile, Implementation of the LD will already result in a shortage of water in the most downstream part of the Main Nile (in the Delta) and in some years no water would reach the Mediterranean Sea.

Table 3-5: Environmental, social and economic indicators for the Main Nile Sub-basin

Parameter/ indicator		CS	IS	LD	FP
Environmental / water resource indicators		**Flow volume (1000 x Mm3) at key points (see schematic in Annex 3)**			
Nile d/s of BN and WN confluence	Mean annual volume	70.338	66.382	50.674	41.060
Nile u/s of Atbara	Mean annual volume	69.714	65.732	49.686	40.068
Nile d/s of Atbara	Mean annual volume	81.067	76.764	57.523	46.465
Nile u/s of Aswan Dam	Mean annual volume	78.501	74.121	54.632	43.263
Nile d/s of Aswan Dam	Mean annual volume	63.651	59.838	44.402	33.033
Nile at Bal Adela	Mean annual volume	43.088	39.275	23.714	12.327
Nile Outflow to Mediterranean	Mean annual volume	12.573	8.760	-8.664	-18.796
		Reservoir storage (billion m^3/a) and Evaporation (billion m^3/a)			
Mean annual evaporation from lakes and wetlands	Total Evaporation	15.270	15.016	12.649	12.904
	From Aswan Dam	13.318	13.012	10.230	10.230
Reservoir storage including	Mean annual storage	181.87	181.87	184.88	185.91
Socio-economic indicators		**Hydropower production, irrigation area and employment indicators**			
Hydropower	Total MW installed	4 112	4 112	5 012	5 412
	Average GWhrs/annum	17916	18411	21725	24875
Irrigation	Irrigation area (ha*1000)	9 280	9 306	9 443	9 454
	Total water supplied to irrigation (billion m^3/annum)	52.316	52.367	54.526	53.349
Employment (irrigation, livestock and fisheries)	1000s of people employed	165 342	165 821	168 279	168 480

3.6 SELECTION OF INTERVENTIONS FOR FURTHER CONSIDERATION

3.6.1 Introduction

In this section of the report a brief overview of the interventions to be taken forward to the next steps of the study are briefly described. This has been done according along sectoral and thematic lines and also according to whether they are transboundary or sub-basin based interventions.

3.6.2 , Hydropower and interconnection projects

3.6.2.1 Transboundary Interventions

Many of the larger hydropower projects can be considered as transboundary in terms of the regulation of the rivers on which they are situated and this aspect is fully taken into consideration with the application of the analytical framework. However in this part of the report only hydropower projects with a transboundary location are included here. The following Interventions have been taken forward:

3.6.2.1.1 Interconnection Project:

EASTERN NILE REGIONAL INTERCONNECTION PROJECT

A study has been prepared for Power Trade between the EN countries (2008), with the conclusion that an export (from Ethiopia) capacity of 1200 MW to Sudan, and 2 000 MW to Egypt, is profitable for the region, benefit to cost ratio varies between 2.7 and 4.0 and the payback period is less than 10 years. Implementation is planned for 2020.

The Mandaya Dam scheme is the key source of power generation. The project is shown in Figure 3-1. The main components include:

- AC/DC Mix with tapping station in Sudan
- Ethiopia exports 3200MW to Sudan and Egypt.
- 500/400 kV substation located at Mandaya HHP equipped with four 500/400 kV transformers 510 MVAr each.
- Four 500 kV AC circuits between Ethiopia and Sudan (570 km)
- AC/DC 2 x 1075 MW converter station located in Sudan, and a SVC.
- 600 kV DC bipolar line between Sudan and Egypt.

Figure 3-1 : Eastern Nile region al Interconnection Project

3.6.2.1.2 Hydropower Projects

HYDROPOWER SCHEMES

All planned identified hydropower projects (dams and reservoirs) are entirely situated in single countries.

RUN-OF-RIVER OPPORTUNITIES ON THE BLUE AND MAIN NILE

As a result of the construction of the GERD and other projects on the Abbay River, the flow characteristics of the Blue Nile will change quite radically, with flows becoming highly regulated. This may create a number of opportunities including the development of additional run-of-river hydropower schemes downstream on both the Blue Nile and the Main Nile. This could include both i) entirely new schemes and ii) the conversion of planned storage schemes, such as the planned Dal or Kajbar projects in Sudan, into

run-of-river (or reduced storage) schemes. **A comprehensive study to evaluate these opportunities is required.**

3.6.2.2 Abbay-Blue Nile Sub-basin

A number of schemes are identified as priority projects and are listed in Table 3-6. These dams and their associated reservoirs represent the favoured combination of a cascade of dams principally aimed at the generation of hydropower. Due to the presence of the GERD under construction downstream their influence on regulation downstream of the GERD will be limited.

Table 3-6 : Priority Hydropower Projects in the Abbay – Blue Nile Sub-Basin

Project Name	Country	River	Installed Capacity (MW)	Status	Planning Horizon
Karadobi	Ethiopia	Abbay	1 600	PFS, Sep 2008	15 -25
Beko Abo Low	Ethiopia	Abbay	935	PFS, Sep 2010	15 -25
Upper Mandaya	Ethiopia	Abbay	1 700	PFS, Dec 2007	15 -25
Lower Didessa	Ethiopia	Abbay	550	Reconnaissance Study, 2001	15 -25

3.6.2.3 Baro-Akobo-Sobat Sub-basin

A number of schemes are identified as priority projects and are listed in Table 3-7. The number of proposed schemes is limited. However, it should be stressed that the considerable potential of the Pibor River which rises in the highlands in South Sudan has not been taken into account. Once the findings of the recently started basin planning study on the Baro-Akobo-Sobat has been completed, there will be additional priority projects to be taken into consideration.

Table 3-7 : Priority Hydropower Projects in the Baro-Akobo-Sobat Sub-Basin

Project Name	Country	River	Installed Capacity (MW)	Status	Planning Horizon
Baro I	Ethiopia	Baro	166	FS, Sep 2006	15 - 25
Baro II	Ethiopia	Baro	479	FS, Sep 2006	15 - 25
Geba I & 2	Ethiopia	Gilo	372	FS, Feb 2005	15 - 25
Birbir	Ethiopia	Birbir	497	Reconnaissance Study, 2001	15 - 25

3.6.2.4 Tekeze-Setit-Atbara Sub-basin

A number of schemes have been identified as priority projects and are listed in Table 3-8.

Table 3-8 : Priority Hydropower Projects in the Tekeze-Setit-Atbaro Sub-Basin

Project Name	Country	River	Installed Capacity (MW)	Status	Planning Horizon
Tekeze 6	Ethiopia	Tekeze	66	unknown	unknown
Tekeze 7	Ethiopia	Tekeze	300	unknown	2015-2020
Tekeze 21	Ethiopia	Tekeze	11.7	unknown	unknown

3.6.2.5 Main Nile Sub-basin

The following schemes have been retained as priority projects and are listed in Table 3-8.

Table 3-9 : Priority Hydropower Projects in the Main Nile Sub-Basin

Project Name	Country	River	Installed Capacity (MW)	Status	Planning Horizon
Sabaloka	Sudan	Nile	120	FS	15 - 25
Shereig	Sudan	Nile	420	FS	15 - 25
Kajbar	Sudan	Nile	360	FS	15 - 25
Dagash	Sudan	Nile	213	FS	15 - 25
Dal	Sudan	Nile	780	FS	15 - 25

3.6.3 Agriculture

3.6.3.1 Sector-wide Interventions

REGIONAL / BASINWIDE AGRICULTURE/IRRIGATION STRATEGY

It is evident that the past experience of unilateral irrigation expansion at the country level cannot continue without resulting in water shortages in parts of the basin. There is an urgent need for the transboundary planning of irrigation to be based on a coherent water availability based strategy. Such a strategy could take into account number of key strategic orientations including:

- Future population projections and the demand for water in the EN Basin.
- Achieving a balance between the cost-effectiveness of proposed schemes and their level of water consumption.
- Moving towards a regional approach to crop selection (appropriate crop for the concerned agro-climatic zones) and a more transboundary approach to food security.
- Improving the water and economic efficiency of the irrigation sector through operationalization of modern approaches to technology, capacity building and management.
- Large-scale support to the rainfed sector

3.6.3.2 Irrigation Sub-sector

3.6.3.2.1 Transboundary Interventions

CAPACITY BUILDING IN THE IRRIGATION SECTOR

In view of the present under capacity of institutions and personnel involved in the irrigation sector, capacity building is a critical regional/national issue to enhance/improve the planning, study, design, implementation and OMM of irrigation schemes and ensure sustainable irrigation development in the EN countries. Capacity building is a continuous process and should be provided at all levels (policy makers, managers, engineers, technicians, WUAs and farmers), through a well-planned and designed short and long term training programme which included on the job training, study tours to visit best practice sites, etc.

IMPROVING THE PERFORMANCE OF THE EXISTING IRRIGATION SCHEMES:

The prevailing water scarcity, increasing competition with other users (industrial and municipal uses), and the strong need for irrigation expansion as well as the need to take into account climate change issues will call for efficient utilization of the available water resources. Since horizontal expansion of irrigation to cope up with the food requirement of the growing population is limited by water scarcity, most of the increased production will have to come from high yields and high cropping intensity. Moreover, the high construction cost of irrigation projects coupled with the need for expensive storage facilities will call for the prioritising of the improvement of water use efficiencies and the overall performance of existing projects, rather than simply going for expansion.

ESTABLISHMENT OF EASTERN NILE IRRIGATION MANAGEMENT INFORMATION SYSTEM (ENIMIS)

One of the major factors contributing to the poor performance of the existing irrigation schemes is poor water management. Among others, low crop yields, drainage and salinity, and environmental and health problems are directly associated with poor water management. The objectives of ENIMIS is to provide real time information on daily climatic data and potential evapotranspiration (ETo) values of an irrigation scheme located anywhere in the EN Basin, via the internet. Farm and irrigation scheme managers, engineers, Water Users Associations, private farmers etc. can then use this information to improve their day to day water management activities. Establishing a pilot project in one of the sub basins might be advisable for a start.

COORDINATED TRANSBOUNDARY APPROACH TO IRRIGATION EXPENANSION

Sustainable irrigation development is crucial in the EN countries in order to increase food security and provide employment opportunities. Irrigation development is more than a means of producing food and is generally seen as one of the opportunities for socio-economic development, contributing to rural employment and the alleviation of poverty. In the particular context of the Eastern Nile countries, irrigation is also a key vehicle for regional cooperation. Irrigation development is among the top priorities of all four countries, which all have ambitious plans for horizontal expansion of irrigation schemes. However, it is unlikely that the unilateral planned expansion will be sustainable due to the constraints posed by water availability. This calls for the countries to exploit every opportunity to increase water availability for the irrigation sector and **shift from unilateral to regional planning of sustainable irrigation expansions** through the attainment of high levels of transparency, trust and cooperation.

3.6.3.2.2 Abbay-Blue Nile Sub-basin

A large number of schemes are identified as priority projects and are listed in Table 3-10.

Table 3-10 : Priority Irrigation Projects in the Abbay – Blue Nile Sub-Basin

Project Name	Hectares	River	Country	Status
Arjo Dedessa Irrigation Scheme	80 000	Dedessa	Ethiopia	FS ongoing
Jema Irrigation Scheme	7 800	Jema	Ethiopia	Reconnaissance
Birr Irrigation Scheme	10 000	Birr	Ethiopia	Reconnaissance
Ribb Irrigation Scheme	14 000	Ribb	Ethiopia	Under construction
Lower Beles Irrigation Scheme	85 000	Beles	Ethiopia	Reconnaissance
Megech Irrigation Scheme	6 532	Megech	Ethiopia	Under construction
Megech Gravity Irrigation Scheme	10 350	Megech	Ethiopia	Under construction
North East Tana Irrigation Scheme	5 750	Lake Tana	Ethiopia	Reconnaissance
North West Tana Irrigation Scheme	6 720	Lake Tana	Ethiopia	Reconnaissance
South West Tana Irrigation Scheme	5 130	Lake Tana	Ethiopia	Reconnaissance
Gilgel Abbay (Gravity System) Irrigation Scheme	10 000	Gilgel Abbay	Ethiopia	Reconnaissance
Negesso Irrigation Scheme	13 800	Negesso	Ethiopia	FS completed
Anger Irrigation Scheme	14 450	Anger	Ethiopia	FS completed
Dedessa Pumping Irrigation Scheme	4 800	Dedessa	Ethiopia	Reconnaissance
Nekemte Irrigation Scheme	11 200	Anger	Ethiopia	Reconnaissance
Lower Dinder (Pumping System) Irrigation Scheme	49 550	Dinder	Ethiopia	unknown
Upper Dinder Irrigation Scheme	10 000	Dinder	Ethiopia	unknown
Galegu Irrigation Scheme	9 900	Geague	Ethiopia	unknown
Rahad Irrigation Scheme	45 100	Rahad	Ethiopia	unknown
Dinger Bereha (gravity/pump) Irrigation Scheme	7 500		Ethiopia	FS
Rahad II Irrigation Scheme	273 000	Blue Nile	Sudan	FS
Great Kenana Irrigation Scheme	190 000	Blue Nile	Sudan	FS

3.6.3.2.3 Baro-Akobo-Sobat Sub-basin

A limited number of schemes are identified as priority projects and are listed in Table 3-11.

Table 3-11 : Priority Irrigation Projects in the Baro-Akobo-Sobat Sub-Basin

Project Name	Hectares	River	Country	Status
Alwero, Dumbong, Irrigation Scheme1	48 265	Alwero	Ethiopia	Master plan
On Baro River, Right Bank, Irrigation Scheme	170 000	Baro	Ethiopia	Master plan
Gilo, RB, Irrigation Scheme	125 000	Gilo	Ethiopia	Master Plan

3.6.3.2.4 Tekeze-Setit-Atbara Sub-basin

A number of schemes are identified as priority projects and are listed in Table 3-12.

Table 3-12 : Priority Irrigation Projects in the Tekeze-Setit-Atbaro Sub-Basin

Project Name	Hectares	River	Country	Status
Humera Irrigation Scheme	60 000	Tekeze	Ethiopia	FS
Wolkayite Irrigation Scheme	50 000	??	Ethiopia	FS
Metema Irrigation Scheme	11 560	Gend Wuha	Ethiopia	Reconnaissance
Angereb Irrigation Scheme	16 540	Angereb	Ethiopia	Master plan
Upper Atbara Irrigation Scheme	200 000	Atbara	Sudan	Under construction

3.6.3.2.5 Main Nile Sub-basin

Given the existing high level of development in this part of the basin, no schemes have been included in the priority list. Priority should be given to improving efficiency and appropriate crop selection.

3.6.3.3 Rainfed Sub-sector

Interventions in the rainfed sector are generally nationally based and no rainfed-specific interventions are included here. However, it should be stressed that improvements in the rainfed sector are included under the watershed managements presented later in this chapter. It should also be noted that the livelihoods of the majority of the rural population in Ethiopia is based on rain-fed agriculture.

3.6.3.4 Livestock Sub-sector

Interventions in the livestock sector are generally nationally based and no rainfed-specific interventions are included here. However, it should be stressed that improvements in the livestock sector are included under the watershed managements presented later in this chapter.

3.6.4 Conservation and Water Resources Management

3.6.4.1 Transboundary Interventions

TRANSBOUNDARY WATER QUALITY MONITORING PROGRAM

The development of a Transboundary Water Quality Monitoring Programme would include a Study Phase followed by an Implementation and Operation Phase run over 4 years and be implemented basin wide. The study phase is envisaged to extend over a period of 12-18 months and include::

- Reviewing water quality standards and guidelines (local and international) and development of a standard set of water quality guidelines and standards for the EN Basin
- Identification of existing and potential pollution sources and pollutants and the analysis of associated environmental, socioeconomic and health risks
- Analysis of current pollution levels using countries' available information followed by field surveys
- Review of current status and quality of baseline water quality data and identification of data gaps and studies required to fill these gaps
- Development of a Water Quality Monitoring Programme for the EN Basin. This would include identification of legal, institutional and capacity related requirements that would need to be addressed and the identification of the required physical, chemical and biological parameters to be monitored.

Implementation would then follow so that the system would be operational and sustainable within the project period.

WASTE WATER TREATMENT

Up-grade and improve waste water treatment capacity in large settlements located along the White, Blue and Main Nile and key tributaries. In terms of focus, the most significant benefits in terms of effort are likely to be linked providing and up-grading the water treatment facilities in Juba in South Sudan and Khartoum in Sudan. These are the two largest settlements located up-stream of the Main Nile and represent large point sources of pollution (domestic and industrial).

POLLUTION REDUCTION AND CONTROL

Reduce pollution from large scale irrigation schemes linked to the use of pesticides and agrichemicals. The focus here should be on the large schemes located adjacent to the Blue Nile in Sudan and Egypt. The lessons learnt from these schemes should be adopted in other irrigation schemes in the area. The reduction pollution from large irrigation schemes can be linked to initiatives to improve water efficiency and output.

EASTERN NILE REGIONAL CLIMATE PROJECTION AND HYDROLOGICAL IMPACT ASSESSMENT

This projects will include

- Capacity building
- Development of detailed regional climate change information based on regional scenarios

TRANSBOUNDARY ENVIRONMENTAL MANAGEMENT AND CAPACITY DEVELOPMENT PROGRAMME FOR EN BASIN

The development of an Environmental Management Programme for the EN Basin would include a Study Phase followed by an Implementation and Operation Phase run over 4 years and be implemented basin wide. The study phase is envisaged to extend over a period of 12-18 months and include:

- Review of existing environmental policies, legislation, standards and guidelines etc. in each of the four EN countries;
- Review of current status and quality of baseline environmental and socio-economic data for the EN Basin and identification of data gaps and studies required to fill these gaps.
- Review of key international environmental standards, policies and guidelines (SSEA, ESIA, Resettlement Action Plans etc.)
- Assessment of institutional and capacity related requirements for the implementation and operation of Transboundary Environmental Management Programme;
- Development of Transboundary Environmental Management and Capacity Development Programme for EN that is aligned with environmental policies, legislation, standards and guidelines etc. in each of the four EN countries and international best practice;
- The capacity development component of the programme would implement capacity building and environmental awareness at a number of stakeholder levels, including local communities, local, regional and national authorities and politicians.

WATER RESOURCES MONITORING, DATA SHARING AND INTEGRATION

The need for improved water resources monitoring in all of the sub-basins has been highlighted. This is particularly important for many tributaries of the Abbay and Blue Nile, and throughout the other two upstream basins with a focus on better understanding the more complex parts of hydrology such as the behaviour of the large wetlands such as the Machar Marshes. From the transboundary perspective, the key issue is that the fruits of improved monitoring at the national level has transboundary benefits. The aim of this project would be to ensure that data are shared, consolidated and integrated at the basin-wide level.

SUDD WETLANDS MANAGEMENT PLAN.

- The Sudd wetland falls outside the EN Region but plays a critical role in managing the hydrology of the White Nile and Main Nile. Due to the conflict in South Sudan very little research has been undertaken in the Sudd Wetlands for the last 40-50 years. There is therefore limited baseline data on the system.

  The Sudd Wetlands also plays a key role in local wildlife migration which takes place between the Sudd Wetlands in the west and the Machar wetlands and higher lying mountainous areas located in Ethiopia to the east. The livelihoods of local communities living in and around the wetlands are also closely linked to the ecological resources and services provided by the Sudd wetlands.

3.6.4.2 Abbay-Blue Nile Sub-basin

RAHAD AND DINDER TRIBUTARIES INTEGRATED WATER RESOURCES DEVELOPMENT PROJECT

An Integrated water resources development project, similar to the recently started study for the Baro-Akobo-Sobat sub-basin, is planned for the basins of these two tributaries.

ABBAY-BLUE NILE SUB BASIN INTEGRATED WATER RESOURCES DEVELOPMENT PROJECT.

An integrated water resources development project, similar to the recently started study for the Baro-Akobo-Sobat sub-basin is planned for the Abbay- Blue Nile sub-basin.

TRANSBOUNDARY NATIONAL PARK (DINDER NATIONAL / ALATISH REGIONAL PARKS)

Establishment of Trans-boundary National Park consisting of Dinder National / Alatish Regional Park. Linked to establishment of park would be the development of a Management Plan for the area.

The Management Plan would include a Community Engagement and Consultation Strategy. The aim of the strategy would be inform local communities of the proposed trans-boundary national parks and identify how to involve local communities in the development of Management Plans for the proposed trans-boundary national parks;.

WATER RESOURCES MONITORING

Upgrading and expansion of water resources and flood warning monitoring networks and systems

3.6.4.3 Baro-Akobo-Sobat Sub-basin

WATERSHED MANAGEMENT PROGRAMME FOR THE BAS

A watershed management programme for the BAS, is planned. This would include:

- Stakeholder consultation, technical training, prioritization of intervention measures
- Regional framework for implementation of watershed projects
- Implementation of prioritized projects

GAMBELLA MACHAR TRANSBOUNDARY NATIONAL PARK

Establishment of Trans-boundary National Park consisting of Gambella National Park and Machar wetland. Linked to establishment of park would be development of a Management Plan for the area.

The Management Plan would include a Community Engagement and Consultation Strategy. The aim of the strategy would be inform local communities of the proposed trans-boundary national parks and identify how to involve local communities in the development of Management Plans for the proposed trans-boundary national parks;.

WATER RESOURCES MONITORING

Upgrading and expansion of water resources and flood warning monitoring networks and systems

3.6.4.4 Tekeze-Setit-Atbara Sub-basin

An integrated water resources development project, similar to study recently started study for the Baro-Akobo-Sobat sub-basin is planned for Tekeze (Setit) and Atbara sub basin.

WATER RESOURCES MONITORING

Upgrading and expansion of water resources and flood warning monitoring networks and systems

3.6.4.5 Other nationally-based interventions

There are a number of national-based interventions that could be included in or supported by the MSIOA Investment Strategy and Action Plan. These are summarised in Table 3-13 .

Table 3-13: Existing and potential environmental interventions/projects

Country	Sub-Basins	Project	Justification
Ethiopia	Abbay Tekeze	Watershed , Soil and forest Conservation Projects	• Responding to the pressing soil erosion and land degradation problem that that prevail in the upper Ethiopian lands • Expanding the scope of the ongoing Watershed management programme • Reducing the sedimentation pressure on the downstream infrastructure
	Abbay Tekeze	Water Supply & Sanitation projects around main tributaries and main urban centres	• Responding to countries' priority plans • Preventing pollution and water diseases around the basin • Improving the public health of population around the basin
	Abbay Tekeze	Detailed ESIA , ESMA , RAP for the proposed hydropower and irrigation projects	• Proper assessment of the baseline environmental and social conditions • Analysing and identifying the positive and negative impacts based on a methodological sound approaches • Mitigation the adverse Impacts • Enhance the positive impacts • Implementation of the best practice related to resettlement and social issues.
		Capacity Building Programmes (Specialized training , Awareness raising , etc) Institutional Support	• Mobilizing adequate and qualified resources to handle the basin environmental issues in the member countries • Building strong institutions that can handle multi-sectoral issues through applying best environmental practice on local and regional levels
	Baro-Akobo-Sobat	Wetlands Management Projects (Mashar, Sudd)	• Enhancing the Environmental functions of the wetlands • Conservation of biodiversity connected with wetlands
	Baro-Akobo-Sobat	Water Supply & Sanitation projects around main tributaries and main urban centres	• Responding to countries' priority plans • Preventing pollution and water diseases around the basin • Improving the public health of population around the basin
	N.A	Capacity Building Programmes (Specialized training , Awareness raising , etc) Institutional Support	• Mobilizing adequate and qualified resources to handle the basin environmental issues in the member countries • Building strong institutions that can handle multi-sectoral issues through applying best environmental practice on local and regional levels
Sudan	Blue	Climate Resilience	• Mitigate the impacts of climate change on vulnerable

	Nile Atbara	Programmes/Projects for vulnerable communities (pastoralists, farmers)	communities around blue Nile and Atbara sub-basins • Improving Productivity
	Blue Nile	Environmental Management Plan for Dinder National Park	• Conservation of biodiversity and Wild Life around blue Nile sub-basin • Conservation of the Wetlands within the Park
	Main Nile Blue Nile Atbara	Interventions on the ongoing Water Harvesting Programme (Conducting Studies, Implementing IWRM plans, etc.)	• Improving Environmental conditions of the targeted areas around the sub basins • Reducing the pressure on the Nile/Blue Nile sub-basins • Improving social conditions of the targeted communities
	Main Nile Atbara	Supporting Existing projects related to combating desertification around the Main Nile and blue Nile Basin	• Conservation of the river morphology • Preventing land and soil degradation
	Blue Nile Atbara	Supporting ongoing afforestation programmes/projects around the sub-basin	• Compensating the lost forest and increasing Carbon sinks • Climate change adaptation measure
	N.A	Capacity Building Programmes (Specialized training , Awareness raising , etc) Institutional Support	• Mobilizing adequate and qualified resources to handle the basin environmental issues in the member countries • Building strong institutions that can handle multi-sectoral issues through applying best environmental practice on local and regional levels
Egypt	Main Nile	Interventions on the Water Quality Programmes	• Preventing river pollution and thus conserving aquatic life • Improving public health conditions • Improving Water Supply facilities in urban centers
	Main Nile	Supporting Soil Desalination Programme at the Deltas area.	
	N.A	Capacity Building Programmes (Specialized training , Awareness raising , etc) Institutional Support	• Mobilizing adequate and qualified resources to handle the basin environmental issues in the member countries • Building strong institutions that can handle multi-sectoral issues through applying best environmental practice on local and regional levels

3.6.5 Cross-sectoral, enabling and non-infrastructural interventions

DAM SAFETY PROGRAMME (ALL EN COUNTRIES)

- Capacity development, dam safety inspection, roadmap for improvement, Emergency Action plan

EASTERN NILE CLIMATE CHANGE DETECTION AND ADVISORY SERVICES AT WATERSHED LEVEL

- Comprehensive database and coordinated monitoring of flow, sediment flux, rainfall, temperature, vegetation cover and other socio-economic variables
- Analytical tools and capacity building

SOCIAL DEVELOPMENT AND COMMUNICATION UNIT

- Capacity building on social developments
- Development and corporate communication products

4. Identification and mapping of keys stakeholders

4.1 INTRODUCTION

The next steps of the study will lead to the development of an Investment Strategy and Action plan for the MSIOA. Project implementation at the national and regional levels will involve a number of stakeholders. The aim of this chapter of the report is to identify the different stakeholders that will be involved.

4.2 KEY SECTORAL/THEMATIC STAKEHOLDERS

4.2.1 Agriculture

4.2.1.1 Key Stakeholders in the Agriculture Sector

Key Stakeholders involved in the planning, development and management of the various sub-sectors in agriculture are summarized in Table 4-1.

Table 4-1: Key stakeholders involved in the Planning, Development and Management of Agriculture in the EN Countries

Projects/ Major Activities	Regional	Ethiopia	South Sudan	Sudan	Egypt
IRRIGATION SUB-SECTOR					
1. Irrigation Expansion					
Coordination/facilitation of Regional identification of safe expansions	ENTRO/NBI	• Ministry of Water, Irrigation and Energy	• Ministry of Electricity, Dams, Irrigation and Water Resources (MEDIWR)	• Ministry of Water Resources and Electricity	Ministry of Water Resources and Irrigation (MWRI)
Planning, study, design and implementation of Public large Scale Irrigation and Drainage projects		• Ministry of Water, Irrigation and Energy	• Ministry of Electricity, Dams, Irrigation and Water Resources (MEDIWR)	• Ministry of Water Resources and Electricity	Ministry of Water Resources and Irrigation (MWRI)
Planning, study, design and implementation of Commercial/Private Irrigation and Drainage projects		• Private Sector	• Private Sector	• Private Sector	Private Sector
Planning, study, design and implementation of Small Scale Irrigation projects (less than 200 ha)		• Regional Bureaus of Water • NGOs			
Operation, Maintenance and management of Public large and Small Scale Irrigation and Drainage projects		• Regional Bureaus of Agriculture • Farm Estates • Water User Associations (WUAs)	• Ministry of Agriculture, Forestry, Tourism, Animal Resources, Fisheries, Cooperatives and Rural Development (MAFTARFCRD)	• Ministry of Agriculture and Irrigation • Water User Associations (WUAs)	• Ministry of Agriculture and Land Reclamation (MALR) • Water User Associations (WUAs) •
2. Improving the Performance of the existing Irrigation Schemes		• Regional Bureaus of Water and Agriculture • Farm Estates	• Ministry of Electricity, Dams, Irrigation and Water Resources (MEDIWR)	• Ministry of Agriculture and Irrigation • Private Sector	• General Authority for Rehabilitation of Projects and Agricultural Development (GARPAD) • Private sector
3. Study for Integrated Transboundary Water Resources Development and Management Project	ENTRO				
4. Establishment of Eastern Nile Irrigation Management Information System (ENIMIS):	ENTRO				

RAINFED AGRICULTURE SUB-SECTOR					
1. Rainfed Agriculture Development and Management		• Ministry of Agriculture • Regional Bureaus of Agriculture • Private Sector	• MAFTARFCRD • Private Sector	• Ministry of Agriculture and Irrigation • Private sector •	•
LIVESTOCK SUB-SECTOR					
1. Livestock Development and Management		• Ministry of Agriculture • Regional Bureaus of Agriculture	• MAFTARFCRD • Private sector	• Ministry of Livestock and Fisheries • Private Sector	• Ministry of Agriculture and Land Reclamation (MALR) • Private Sector •
FISHERIES SUB-SECTOR					
1. Fisheries Development and Management		• Ministry of Agriculture • Regional Bureaus of Agriculture • Private Sector	• MAFTARFCRD • Private Sector	• Ministry of Livestock and Fisheries • Private Sector	• General Authority of Fish Resources Development (GAFRD) in the MALR • Private Sector
ALL SUB-SECTORS					
1. Capacity Building to all Agricultural sector institutes, policy makers, planners, professionals, farmers, etc	• ENTRO	• Ministry of Water, Irrigation and Energy, • Ministry of Agriculture, • Regional Bureaus of Water and Agriculture, • Donors and NGOs	• Ministry of Electricity, Dams, Irrigation and Water Resources • MAFTARFCRD • Donors and NGOs	• Ministry of Water Resources and Electricity, • Ministry of Agriculture and Irrigation	• Ministry of water Resources and Irrigation • Ministry of Agriculture and Land Reclamation (MALR) • Donors

4.2.2 Hydropower and Interconnection projects

4.2.2.1 Planning and Decision-making

Planning and decision-making for (large-scale) hydropower and interconnection projects is done by Governmental stakeholders and inter-government organisations and involves the following stakeholders:

- Ministries responsible for **Strategic Planning**

  To Plan for the Hydropower Project and/or Electrical Interconnection Projects in the frame of Country Strategy.

- Ministries responsible for **Water Resources**

  Owner of hydropower projects, present laws and regulations to Cabinet for endorsement, oversees the utilities performance, coordinate with other ministries.

- Ministries responsible for **Electricity**

  To Plan for the implementation of Electrical national and regional Interconnection Projects, Prepare related laws and present to Cabinet, Propose Tariff, sign agreements for Regional Interconnection Projects and Promotes power trade and regional cooperation.

  Identify the structure of the sector, roles and responsibilities to the institutions and oversee their performance.

- Ministries Responsible for **Financing**

  Secure Finance the project within the country budget.

- Ministries responsible for **International Cooperation**

  Negotiate and sign international Agreements for financing or implementation of the projects.

- Ministries responsible for **Foreign Affairs**

  Negotiate agreements with other countries for Electrical Interconnection Projects.

- Ministries responsible for **Environment**

  To put regulations and guides for Environment protection. Enforcement of environmental safeguards in the projects.

- Ministries responsible for **Land Reclamation**

  To avail land for the projects.

- Cabinet/ Parliament to approve and indorse the projects.

For the four countries of the Eastern Nile these are summarised in Table 4-2.

Table 4-2 : Stakeholders involved in Planning and Decision-making in the Hydropower Sector

Ethiopia	South Sudan	Sudan	Egypt
• Ethiopia Parliament • Ministry of Economic and Finance • Ministry of Water, Irrigation and Energy • Ministry of Trade and Investment • Ministry of Foreign Affairs •	• Ministry of Cabinet Affairs • Ministry of Electricity, Dams, Irrigation & Water Resources • Ministry of Commerce, Industry and Investment • Ministry of Environment • Ministry of Finance and Economic Planning • Ministry of Foreign Affairs and International Cooperation	• Minister of Environment, Forestry & Physical Development • Ministry of Investment • Ministry of Electricity & Dams • Ministry of Irrigation & Water Resources • Ministry of International Cooperation • Ministry of Finance & National Economy • Ministry of Foreign Affairs	• Cabinet/ Parliament • Ministry of Water Resources and Irrigation • Ministry of Electricity and Renewable Energy • Ministry of International Cooperation • Ministry of Foreign Affairs • Ministry of Economics and Finance • Ministry of Environment • Ministry of Planning • Ministry of Investment

4.2.2.2 *Implementation*

Stakeholders involved in Implementation of hydropower and irrigations projects include both utilities (which are generally parastatals or privately run).

- **Utilities**
  - Utilities responsible for implementing the Hydropower Projects

    Plan, Studies, Design, finance, Procurement, Manage Construction, agreements, Operation, Maintenance and resettlements of people.
  - Utilities responsible for implementing the Electrical Interconnection Projects

    Plan, Studies, Design, finance, Procurement, Manage Construction, Negotiation, agreements, Operation, Maintenance and resettlements of people.
  - Utilities responsible for National Planning
  - Regulator

    To protect the rights of the electricity companies and the consumers, issue license for private sector.

    Regulation of all sector activities including cross-border trade, and support of private sector participation; Investment legislation that protects investor's interests and provides incentives for private sector investments.

    Licensing of cross-border trade, and Propose Tariff pricing for Cabinet approval.
- **Private Sector**
  - Consulting Firms

    For preparation of FS, supervision implementation and construction.
  - Contractors

    For construction of the projects.
- **Non-Governmental Organizations**
- **Media, Newspapers**
- **Consumers of Electricity**

Table 4-3 : Stakeholders involved in Implementation in the Hydropower Sector

Ethiopia	South Sudan	Sudan	Egypt
• Ethiopian Electric Power Corporation (EEPCo) • Ethiopian Electric Power (EEP) • Ethiopian Electric Utility (EEU) • Electricity Regulator • Ethiopian Investment Commission • Federal Environmental Protection Authority (EPA) • Ministry of Construction • Private Sector Consulting Firms	• South Sudan Electricity Company (SSEC) •	• Electricity Regulatory Authority • Sudanese Electricity Transmission Company Ltd. (SETCO) • Sudanese Hydropower Generation Company Ltd. (SHGC) • Sudanese Electricity Transmission Company Ltd. (SEDCO) • Higher Council of Environment • Private Sector Consulting Firms • Private Sector Contractors • TV, Newspapers, …etc	• Egyptian Electricity Holding Company (EEHC) • Electricity Generation companies • Egyptian Electricity Transmission Company (EETC) • Hydropower Plant Authority • Nile Water Sector

4.2.3 Conservation and Natural Resources Management

4.2.3.1 Types of project/intervention

Based on the findings of the Country Consultations and Situational Analysis two areas of intervention were identified in the EN Basin namely:

- Establishment of Trans-boundary National Park consisting of Dinder National / Alatish Regional Park. Linked to establishment of park would be development of a Management Plan for the area;
- Establishment of Trans-boundary National Park consisting of Gambella National Park and Machar wetland. Linked to establishment of park would be development of a Management Plan for the area;

In addition it is recommended that Management Plan be developed for the Sudd wetland, which falls outside the EN Region but plays a critical role in managing the hydrology of the White Nile and Main Nile. Due to the conflict in South Sudan very little research has been undertaken in the Sudd Wetlands for the last 40-50 years. There is therefore a critical need to undertake research in this area.

Given that the location of the proposed trans-boundary parks the Management Plans would need to include current uses, specifically the importance of the areas in terms of livelihoods of local communities and pastoralists. The focus of the Management Plans would therefore be on how to best to protect the natural resources of the area while at the same time addressing the needs of local communities. The Management Plans would also need to identify appropriate land uses and activities within the park boundaries, including potential hydro-power dams and irrigation schemes.

The proposed Trans-boundary Dinder / Alatish National Park is located in the Abbay-Blue Nile sub-basin within Sudan and Ethiopia.

The Dinder National Park has a high level of biodiversity. Conservation management combined with watershed management will benefit downstream communities and water users. The park is also critical to the livelihoods of a number of local groups. These include a small group of Maganu people that live in the south-eastern part of the park. The second

group are pastoralists and agro-pastoralists who enter the Park in the dry season looking for forage and water because much their rangeland has been converted into semi-mechanized farms. A large number of Internally Displaced Peoples are settled along the Dinder and Rahad Rivers and enter the Park for fishing, fuelwood and also for illegal hunting. It is estimated that 100,000 people live around the park in 36 villages.

The Alatish Regional Park is located in Ethiopia, almost opposite the Dinder National Park in the Sudan. The area represents the Sudan- Guinea Biome, and covers an area of 2 666 km^2 to the north of the Dinder River. The Alatish and other ephemeral streams drain the central area. The area is intact with no permanent settlement, although Fellata pastoralists enter the Park in the dry season with over 10,000 head of livestock. The Ethiopian Wildlife Conservation Organization has strongly recommended that the Alatish Park been proclaimed a National park and that in the future it should form part of a Transboundary Park with the Dinder National Park.

The proposed Transboundary Gambella- Machar wetlands National Park is located in the Baro-Akobo-Sobat-Main Nile sub-basin within Ethiopia and South Sudan respectively. The Sudd wetland falls outside the EN basin, however, the wetlands are the largest wetlands in the world and play a critical role in managing the hydrology of the White Nile. The wetlands also play a key role in local wildlife migration which takes place between the Sudd Wetlands in the west and the Machar wetlands and higher lying mountainous areas located in Ethiopia to the east. These areas include the Gambella National Park. Likewise, the Sudd and Machar wetlands play an important role in the livelihoods of local communities living in the area, including pastoralists.

The establishment of the proposed Transboundary Parks and the development of a Management Plan for the Sudd Wetlands create an opportunity to address a number of challenges and opportunities identified during the Country Consultations, these include:

- Addressing the loss of biodiversity in the EN Basin and the loss of key natural resources;
- Undertaking much needed research in the affected areas, including up-dating existing baseline information. Due the international importance of these areas there is likely to be widespread international (World Bank, UNEP, UNDP, IMF, AFDB etc.) support for programmes aimed at ensuring that these areas are protected. This would create an opportunity for implementation of internationally funded research programmes which, in turn, would create opportunities to improve and develop capacity and skills in the EN Basin, specifically Ethiopia, South Sudan and Sudan;
- Understanding the role and importance of the environmental goods and services provided by these areas for the EN Basin;
- Developing and implementing catchment management and erosion control programmes within key catchment areas within the Baro-Akobo-Sobat-White Nile and Abbay-Blue sub-basins;
- Addressing conflicts over access to natural resources by developing community resource management programmes whereby the local communities are actively involved in design and implementation of conservation programmes. As indicated in the Situation Analysis the majority of conflicts in the Abbay-Blue Nile and Baro-Akobo-Sobat-Main Nile sub-basins are linked to competition over and access to natural resources, specifically land and water. Many of these conflicts have been aggravated by the failure of national and local authorities to take into consideration traditional livelihoods strategies of local groups and communities. These issues will need to be addressed in the development of Management Plans for the respective areas;
- Promoting tourism in the EN Basin, especially the Abbay-Blue Nile and Baro-Akobo-Sobat-Main Nile sub-basins.

4.2.3.2 Implications for Stakeholders at the Regional and National Levels

REGIONAL LEVEL

Planning and decision-making

The establishment of the proposed Dinder Alatish and Gambella-Machar Trans-Boundary Parks would require consultation between the relevant national governments, namely Ethiopia, Sudan and South Sudan. A number of large, trans-boundary national parks have been established and or are in the process of being established in Southern Africa involving South Africa, Mozambique, Namibia, Zimbabwe and Zambia. The key lessons learnt from the development of these parks should be used to guide the development of the proposed trans-boundary parks in the EN Basin. A key component of the establishment of these parks has been the involvement of the local communities in the design and development of the Management Plans for these areas. A similar process should be followed for the development of the proposed Dinder Alatish and Gambella-Machar Trans-Boundary Parks. Local communities should also be involved in the design and development of the Management Plan for the Sudd Wetlands.

Implementation

The establishment of the proposed trans-boundary national parks would involve:

- High level consultations between representatives from Ethiopia, Sudan and South Sudan. The aim of these consultations would be to agree in principle on the need and importance of establishing the proposed trans-boundary national parks;
- Consultations between relevant ministries in from Ethiopia, Sudan and South Sudan regarding extent and location of boundaries for the proposed trans-boundary national parks;
- Development of a Community Engagement and Consultation Strategy. The aim of the strategy would be inform local communities of the proposed trans-boundary national parks and identify how to involve local communities in the development of Management Plans for the proposed trans-boundary national parks;
- Implementation of Community Engagement and Consultation Strategy;
- Proclamation of proposed trans-boundary national parks;
- Development of Management Plans. As indicated above, the management of the areas would need to include the needs of local communities and pastoralists;
- Implementation of Management Plans, including research programmes.

Users, beneficiaries and affected parties

The main users, beneficiaries and affected parties would include:

- Local communities living in and or adjacent to the proposed trans-boundary parks;
- Pastoralists that use the natural resources in the proposed trans-boundary parks;
- Researchers and relevant government departments;
- Residents of Ethiopia and local and international tourists;
- Downstream water users due to improved catchment management;
- The regional and international community that benefit from the conservation of bio-diversity and endangered species)
- Future generations (local, regional and international) that benefit from the due to protection of scarce habitats and endangered species

AT THE NATIONAL LEVEL - ETHIOPIA

Planning and decision-making

The main stakeholders in the project planning would include:

- Environmental Protection Authority and the Ministry of Water and Energy
- Federal Ministry of Water, Irrigation and Energy
- Federal Ministry of Water, Irrigation and Energy;
- Ministry of Agriculture;
- Ministry of Environment and Forests
- At the National Level - South Sudan
- Ministry of Agriculture, Forestry, Cooperation and Rural Development
- Ministry of Electricity, Dams, Irrigation and Water Resources
- Ministry of Environment
- Ministry of Wildlife

AT THE NATIONAL LEVEL – SUDAN

- Higher Council for Environment and Natural Resources (under the Ministry of Environment and Physical Development);
- Ministry of Environment;
- Ministry of Water Resources
- Ministry of Agriculture and Irrigation; Ministry of Electricity, Dams, Irrigation and Water Resources

AT THE NATIONAL LEVEL - EGYPT

Not implicated

4.2.4 Water Quality and Pollution

4.2.4.1 Types of Project / intervention

Based on the findings of the Country Consultations and Situational Analysis two key areas of intervention were identified, namely:

- Up-grade and improve waste water treatment capacity in large settlements located along the White, Blue and Main Nile and key tributaries. In terms of focus, the most significant benefits in terms of effort are likely to be linked providing and up-grading the water treatment facilities in Juba in South Sudan and Khartoum in Sudan. These are the two largest settlements located up-stream of the Main Nile and represent large point sources of pollution (domestic and industrial).
- Reduce pollution from large scale irrigation schemes linked to the use of pesticides and agrichemicals. The focus here should be on the large schemes located adjacent to the Blue Nile in Sudan. The lessons learnt from these schemes should be adopted in other irrigation schemes in the area. The reduction pollution from large irrigation schemes can be linked to initiatives to improve water efficiency and output.

Water quality was identified as a key challenge facing the EN Basin, specifically in Egypt, which is totally dependent upon the Main Nile for its water needs. The main pollution sources

are linked to intensive irrigation and the associated use of pesticides and fertilizers, industrial discharges and untreated domestic waste water. An assessment of water quality in Egypt indicated that the major water quality problems are pathogenic bacteria/parasites, heavy metals and pesticides. Major sources of these pollutants are the uncontrolled discharge of human, industrial and agricultural wastes.

According to the United Nations Population Division in 2010 approximately ~214 million people lived in the countries that make up the Eastern Nile (EN) Basin, namely Egypt, Ethiopia, South Sudan and the Sudan. Of this total, 151 million (71%) lived in the basin area. The projected increase in population of the EN Basin will place growing pressure not only of the supply of water but also on the quality of this scarce resource. Poor water quality impacts on human health, which in turn impacts on productivity and economic performance. Impact on human health also places pressure on national and local health services.

The findings of the Situation Analysis and Country Consultations indicated that water quality and the lack of access to potable water and sanitation were key challenges facing all of the countries in the EN Basin. Sanitation and waste water treatment facilities in the large settlements located along the White, Blue and Main Nile, such as Juba and Khartoum are either non-existent and or old and inadequate. The majority of the smaller settlements located along the White, Blue and Main Nile and the associated tributaries have no waste water treatment facilities. Untreated domestic waste is discharged directly in to the rivers that ultimately become the Main Nile which provides Egypt with the bulk of its water supply. The large scale irrigation schemes located largely in Sudan are also a significant source of pollutants. The settlements and irrigation schemes located along the Main Nile in Egypt also contribute to the pollution levels

4.2.4.2 Implications for Stakeholders at the Regional and National Levels

AT THE REGIONAL LEVEL

Planning and decision-making

At a regional level the benefits of addressing water quality and pollution would be largely felt by Sudan and Egypt, specifically Egypt due to its location in the EN Basin. However, the communities located in four sub-basins in each of the four countries in the EN Basin would all benefit from improved water quality.

At a regional level the key role players would therefore include representatives from South Sudan, Sudan and Egypt

Implementation

As indicated above, the focus should be on:

- Providing and up-grading the water treatment facilities in Juba in South Sudan and Khartoum in Sudan ;
- The large irrigation schemes located adjacent to the Blue Nile in Sudan. As indicated above, the reduction pollution from large irrigation schemes can be linked to initiatives to improve water efficiency and output

Measures required to ensure that this happens include:

- Consultations between relevant ministries from Sudan, South Sudan and Egypt. The aim of these consultations would be discuss current status of water treatment facilities in Juba and Khartoum and identify need for new facilities and measures required to up-grade existing facilities. These measures would take into account future projected population growth estimates for Juba and Khartoum;

- Consultations between relevant ministries from Sudan and Egypt. The aim of these consultations would be discuss measures to reduce pollution from irrigation schemes. Representatives from South Sudan and Ethiopia should also be part of these discussions as this would inform the design and management of future irrigation schemes to be developed in these countries;
- Identification of potential funders to fund development of new facilities and up-grades for existing water treatment facilities in Juba and Khartoum. This would from part of the outcome of the MSIOA study;
- Development and submission of funding applications to fund development of new facilities and up-grades for existing water treatment facilities in Juba and Khartoum

Users, beneficiaries and affected parties

The main users, beneficiaries and affected parties would include:

- Local communities living adjacent to the White, Blue and Main Nile that rely on these rivers for their water supply ;
- Governments of Ethiopia, Sudan, South Sudan and Egypt due to improved water quality and reduced impact on human health and economic activity ;
- Future generations (local, regional and international) that benefit from improved water quality and health conditions

AT THE NATIONAL LEVEL - ETHIOPIA

Planning and decision-making

- Environmental Protection Authority and the Ministry of Water and Energy
- Federal Ministry of Water, Irrigation and Energy
- Ministry of Agriculture

AT THE NATIONAL LEVEL – SOUTH SUDAN

Planning and decision-making

- Ministry of Agriculture, Forestry, Cooperation and Rural Development
- Ministry of Electricity, Dams, Irrigation and Water Resources

AT THE NATIONAL LEVEL - SUDAN

- Ministry of Water Resources ;
- Ministry of Agriculture and Irrigation; \
- Dams Implementation Unit of the Ministry of Electricity and Water Resources

AT THE NATIONAL LEVEL - EGYPT

Not implicated

5. Identification of strategic environmental, and socioeconomic issues and orientations

5.1 Introduction

Based on the analysis carried out using the preliminary analytical framework introduced in Chapter 2 it has been possible to identify the main strategic environmental, and Socio-economic issues and orientations associated with different levels of water resources development. This will provide the basis for the more **detailed investigation of development and management scenarios** in the next step of the study.

This exercise has been carried out for each of the sub-basins but some observations can be made at the basinwide level.

5.2 Basin-wide Perspective

One of the objectives of the MSIOA study is to put aside consideration of national borders while at the same time taking into account national priorities and concerns.

Three of the critical areas affecting all four countries are food security, a growing deficit in the availability of electricity and the degradation of land and water resources.

Irrigation

It is undeniable that the both irrigation expansion (coupled with improved efficiency) and a more productive rainfed sector will be required to meet food security needs for growing populations. In view of the dwindling water resources it is also clear that improved irrigation efficiency and expansion must be carefully planned and that it **should take account of the relative advantages offered by the different parts of the basin** rather than unilateral development along national lines.

- Crop selection should be **done according to agro-climatic zones** rather than local need for that crop. This would ensure the most efficient water application rates and highest yields
- Demand for different produce should be met through an **improved transboundary supply chain**

Hydropower

The rapid expansion of hydropower and the continued development of regional interconnection is a critical component of poverty reduction strategies and is also important in the fight against environmental degradation.

Prioritising the development of hydropower projects should not only take into account the economic aspects, but also the efficiency of the projects in terms of consumption. Developments with low associated evaporation losses (run-of-river and efficient reservoirs) should be prioritised since unnecessary evaporation is something that the basinwide water resources cannot afford.

5.3 ABBAY/BLUE NILE SUB-BASIN

5.3.1 Overview

The Abbay Basin has large hydropower potential. The development of all the identified projects would result in the generation of more than 55 GWhrs/annum, highly significant for both Ethiopia and the region. Much of the irrigation potential to be developed would be dependent on the storage and regulation provided by the hydropower reservoirs and indeed the development of irrigation contributes to the economic viability of the hydropower projects.

The extent of the impact of the proposed irrigation consumption in the Abbay sub-basin on hydropower production should be more carefully assessed in the next step of the study. Given that full irrigation expansion decreases the mean annual runoff available at GERD by over 10%, the impact of irrigation on hydropower will not be insignificant.

The impact of the potential expansion of irrigation using water from the Blue Nile further downstream in Sudan would be very significant. If all identified projects were to be implemented, the flow in the Blue Nile at Khartoum would be more than halved to around 21 billion m^3.

The impact of a reduced contribution from the Blue Nile would have an impact on hydropower in the Blue Nile and more significantly further downstream in the main Nile. It would also contribute to water scarcity for irrigation further downstream.

5.3.2 Strategic Orientations

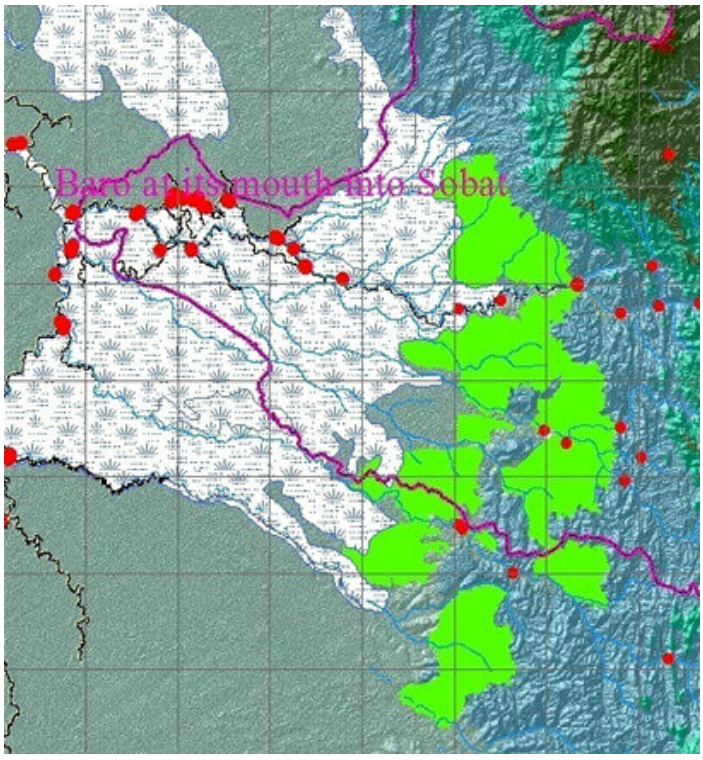
The strategic development focus in the Abbay basin should clearly be on the development of hydropower. Some observations can be made:

- While priority should be given to hydropower, there are opportunities for the dual/multipurpose use of reservoirs as part of a cascade development.
- The development of a cascade of reservoirs has a number of strategic advantages both within the sub-basin and beyond. These include:
  - Regulation of flood events and increase of the low season flow,
  - Trapping of sediment, which improves efficiency of large scale irrigation schemes in Sudan,
  - Improved water security by storing water in narrow, deep reservoirs at higher, cooler altitudes, therefore reducing overall evaporation losses
  - Major opportunity for hydropower generation
  - Social and environmental impacts are low relative to the size of dams, due to the low population density in Abbay Gorge, and limited irrigation and farming due to steepness of gorge. The biodiversity is also low, due to the high energy nature of the system during the flood events, coupled with extremely high sediment loads.
- Due to the cascade nature of the proposed hydropower power projects, the consumption of water by irrigation as part of a dual purpose reservoir upstream will have impacts on hydropower generation at the reservoirs downstream.
- There is a trade-off between hydropower and irrigation within the sub-basin. This needs to be carefully evaluated.
- Strategic choices have to be made with respect to multipurpose development options.

5.4 BARO-AKOBO-SOBAT WHITE NILE SUB-BASIN

5.4.1 Overview

The impact on flows in the White Nile of major irrigation expansion in the sub-basin is subdued by the presence of the Machar wetlands. This is effectively because a significant portion of the water consumed by irrigation would have been "lost" to evaporation from these wetlands in any case.



The fact that the majority of hydropower sites and their associated storages are upstream of the identified irrigation projects means that the irrigation projects can take advantage of a regulated flow and that irrigation water consumption should not have an impact on hydropower production. The presence of several new hydropower schemes with storage reservoirs in the Upper Baro, Gilo and Alwero tributaries has an impact on the seasonality of flows downstream. This will be significant for the Machar Wetlands whose ecology depends not only on adequate inflows but also on the natural seasonality of flows with wetter and drier periods.

Figure 5-1: Location of Irrigation expansion upstream of Machar Wetlands

- The irrigation projects that are not located within the Gambella National Park (Baro Right Bank (1, 2 and 3) and Gilo Left Bank (11, 12 and 13) are all located adjacent to the Gambella National Park and within the catchment area for the Baro, Alwera and Gilo Rivers which join up with the Akobo before becoming the Sobat and flowing into the Machar Wetlands.
- The establishment of the proposed irrigation schemes (those within and those located outside of the Gambella National Park) will result in the loss of natural vegetation and biodiversity in one of the last relatively undisturbed catchments in the EN Region. This will impact negatively on the ecological functioning of the Baro-Akobo-Sobat sub-basin.
- The low lying western areas of the Baro-Akobo-Sobat sub-basin have high concentrations of wildlife and is also home to the second largest animal migration in the world, namely the annual migration of the white eared kob antelope. The establishment of large scale irrigation schemes in the catchment of the key rivers that make up the sub-basin is likely to impact negatively on the wildlife that rely on the flow of water from the Ethiopian Highlands in the east.

- The livelihoods of the local communities in the area downstream of the proposed irrigation schemes and the Gambella National Park are also closely linked to the use of and availability of natural resources, specifically water and grazing. Any impact on the availability and water quality, specifically during the dry season, would increase the potential for conflicts over scarce resources.

5.4.2 Strategic orientations

- While the maximisation of irrigation upstream of the Machar wetlands has a relatively lower impact on the overall water resources of the Blue Nile system the potential negative impacts on the Machar wetlands should be carefully investigated and mitigation measures proposed. Given the potential value of economic development, both in terms of hydropower production and irrigation, a large-scale and detailed environmental impact assessment is required, not on a scheme by scheme basis, but for the possible combined development options.
- Operation rules for the reservoirs associated with hydropower in the upper parts of the sub-basin should be optimised and synchronised in order to allow some degree of mimicking of the natural seasonality of flows entering the Machar wetlands, while at the same time providing adequate water for irrigation.
- Continued and improved monitoring of levels and discharges is important throughout the EN basin and recommendations in this respect are included in Section 4.6. However, given the environmental sensitivity of the Machar Mashes and the Twalor wetlands, it is considered very important to improve hydrological monitoring both upstream of the wetland and within the wetlands themselves.

5.5 TEKEZE-SETIT-ATBARA SUB-BASIN

5.5.1 Overview

In its current state, the Tekeze-Setit-Atbara sub-basin, is the smallest of the three upstream basins in terms of its contribution to the main Nile. Irrigation and hydropower potential are also relatively limited. Full development of potential would see the flow reaching the main Nile reduced by around 5 billion m^3.

5.5.2 Strategic Orientations

Development in this sub-basin is currently limited and there is likely to be pressure for development to bring both employment opportunities and food security and in general to alleviate poverty.

- It makes sense to couple irrigation development with hydropower where possible in order to improve the economic viability of development and priority should be given to these opportunities.
- In terms of feasibility basin-wide at the level of this study, the opportunities in the Tekeze-Setit-Atbara sub-basin are no better than in the other two upper sub-basins. Prioritising the implementation of irrigation projects will depend on more detailed comparative feasibility studies and on the localised need for development and employment. Also on the availability of transport links and access to markets, either existing or planned.

5.6 MAIN NILE SUB-BASIN

5.6.1 Overview

Little new development is planned in the Main Nile. Levels of irrigation development are already high with nearly 60 million m^3 consumed by irrigation.

The mean annual flow in the Main Nile will reduce as a result of upstream development. At the same time the flow, although reduced, will be much more regulated providing opportunities for some additional hydropower production in the upper part of the sub-basin.

5.6.2 Strategic Orientations

Interventions in the main Nile should be orientated toward making the most of a more regulated flow. Irrespective of the levels of development that proceed in the upper part of the basin, the flows will be considerably more regulated as a result of the GERD and other reservoirs for hydropower.

- Implementation of hydropower projects in the upper part of the sub-basin in order to take advantage of the more regulated flow
- Improved efficiency of irrigation schemes in the sub-basin in order to maximise crop per drop from a potentially reduced volume of water availability.
- The phasing out of inappropriate crops, grown largely to satisfy local, national Demand is essential.
- Consideration of options to reduce evaporation losses from the Aswan Dam. Increased upstream regulation of the upstream flows will mean that the volume of water required in the reservoir of the High Aswan Dam for regulation is considerably reduced. Of course, while a reduced storage will reduce evaporative losses, hydropower generation will also be reduced. The optimum operation rule for the Aswan High Dam will therefore be a trade-off between reducing evaporation and reduced hydropower generation.

6. Conclusions and the Way Forward

6.1 Introduction

The primary task of the Situational Analysis and this report was to identify the interventions for taking forward to the next steps of the study. The use of exploratory scenarios has also permitted the drawing up of some strategic orientations. This will allow the work to be focussed on the definition of a set of more realistic and useful development scenarios for more detailed and focussed investigation. These likely case scenarios should be those that are realistic in terms of the fundamental environmental and socio-economic criteria.

While the preliminary framework has provided us with an indicative way forward, it is broad-based and has not attempted to look at the relative benefits of the alternative projects that could comprise competing scenarios or variations within scenarios.

In addition to looking in more detail at the water resources and environmental implications of the potential water resources development scenarios, the next step of the study will also see the focus shift to an assessment of the relative benefits at the project (and combination of projects) level.

6.2 Investigation of Detailed Scenarios

In the next step of the study a significant number of scenarios will be investigated in order to provide direction for the drawing up of an Investment Strategy and Action Plan. One of the aims of looking at these scenarios will be to quantify some of the strategic orientations that have come out of this report. The aim will be to provide decision-makers and planners with a sound basis for moving towards a basinwide sustainable water resources development strategy which supports a level of energy and food security, socio-economic development and production, much higher than could be achieved by unilateral approaches.

6.3 Application of Economic Criteria

A key aspect of the next step will be the inclusion of economic criteria. All the included projects should individually have a

- positive Internal rate of return –IRR-
- positive Net present value – NPV and
- cost-benefit ratio less than 1

In the next step of the study these factors will be taken into account in order to compare development options in terms of combinations of projects and then to prioritise, largely according to economic criteria.

The economic model is build using Microsoft Excel. The Excel system of spreadsheets file is clearly organized in order to facilitate understanding. For each scenarios, the following economic indicators will be calculated. These economic indicators are the one usually used for evaluating public investment such as hydropower or irrigation schemes.

- Economic Net Present Value (ENPV).

- Economic Internal Rate of Return (EIRR).
- Cost-benefit ratio

Details of how these are calculate are provided in Annex 2.

Others economic indicators could be used if data is available. Such indicators are:

- Output employment: Estimate of the generation and losses of employment per country for each scenario.
- Output food security. Assessment of the contribution of the various development scenario to the food security in each country.

ANNEXES

Annex 1: Annual Water Balance and Economic Assessment Tool

INTRODUCTION

The annual water balance and economic assessment model is the other tool at the heart of the analytical framework. Such a tool provide the following:

- Detailed annual water balance analysis to study the implications of different scenarios on water availability at each node on the system;
- **T**he Economic Assessment tool to assess from an economic point of view the multisector development opportunities in the EN region provide a unique knowledge base for the EN MSIOA Project which include the following:
  - Detailed project database and description for all existing and potential investment schemes. This include infrastructures, scheme operation and productivity, historical water abstractions and economic viability of the scheme.
  - Updates of unit rates for potential irrigable projects in Egypt, Sudan and South Sudan. For the case of Ethiopia the Diagnostic component of the EN Irrigation and Drainage Study provide fairly adequate and updated economic analysis of potential irrigable schemes in Ethiopia. Access to Data and information about existing and potential schemes from different sources were mainstreamed as part of the EN-MSIOA Knowledge base platform.
  - Detailed Costing Analysis and systematic computation procedure for evaluation of Initial Infrastructure investment costs and recurrent costs for all irrigation schemes;
  - Computations of water requirements for irrigation, livestock and feed water requirements, pumping requirements for all irrigation schemes. This include estimate of water requirements per unit hectares, equilibrium price of water and cost of pumping per unit hectare.
  - Estimation of production costs and net revenues generated from existing and potential irrigable projects. This permit analysis of the impact of different irrigation modernization options and economic valuation of the feasibility of rehabilitating low performing irrigation projects.
  - Detailed socio-economic analysis based on consistent set of indicators for prioritizing the set of investment projects. This include the following:
    - Benefit Cost Analysis for economic evaluation: Net Present Value (NPV), Internal Rate of Return (IRR) and Benefit Cost Ration (B/C);
    - Employment generated from each irrigation scheme;
    - Livestock and fishery productivity;

A detailed draft description of the Water Balance and Economic Assessment tool, how it would work, inputs required, linkages with the EN Basin Planning Model and anticipated outputs was submitted to ENTRO in December 2014 and subsequently presented at a Client/Consultant meeting. This ensured that the economic model should deliver the expected results. Potential combinations of water development activities were also discussed with ENTRO.

The aim of the Annual Water Balance and Economic Model is to assess from an economic point of view the multisector development opportunities in the EN region. The structural investments (mainly hydropower and irrigation investments) taken into account in the model are those already identified in the situational analysis main report. Added to the identified structural investment, a number of hypotheses have been taken to estimate the potential improvement in others sectors such as integrated watershed management; fisheries, fish

farming, livestock... The degrees of development assumed for each sector is detailed in Chapter 3.

The economic model is described in sections 2.4.2 to 2.4.7. However, in order to achieve an intimate understanding of the impacts of different inputs on outputs, it is useful to develop hands-on experience on the economic model itself.

DESCRIPTION OF THE TOOL

The economic assessment is carried out over a 30 year time period. A 25 year time period for instance would be considered too short to assess the benefits of major investments such as dams. Indeed, with a time line of only 25 years, a large part of the benefits derived from these major investments will be lost and will in fact reduce automatically, because of the discounting rate and the cost benefit ratio. All the monetary data are provided in USD. The model has been built in Microsoft Excel. The Excel spread sheets file is clearly organized in order to facilitate understanding and to ensure that the economic model is a living component of the analytical framework that will be handed over to the Client at the end of the study for future application. The structure of the file is as follows:

- A "Mainpage" spreadsheet for testing and visualizing the results from each scenario;
- A "Schematic" spreadsheet. This sheet shows detailed description of the EN System, its components, and provide linkage for the EN reservoir and irrigation database as well as access to historical time series flow records at each gauging nodes in the system.
- A "massbalance" spreadsheet. This sheet provide detailed annual mass balance computations at each node in the sense and its interactive in the sense that Annual mass balance computation at each node will be updates with changing the selected scenario.
- A "scenariomanager" spread sheet. This sheet provide controls for the potential investment projects and their development level, the user would like to consider as part of the scenario analysis. It is on this sheet that enable the user to create and test new scenarios. For each of the existing and potential investment projects, A multiplier set of 4 elements is provided under each development level (CS, IS, LD, FP). These multiplier elements could either take a value of 1 or 0. By changing the value from 0 to 1 or vice-versa, this would switch the development level for that particular project on and off. Such arrangement would enable the formulation of scenarios based on different combinations of levels of development and to rank and prioritize projects based on user defined set of socio-economic indicators and/or from national country priority perspectives. Such tool could be very powerful in facilitating informed decision making and joint fact findings or negotiations around alternative development options among conflicting users and stakeholders in the basin.
- **T**he rest of the sheets provide detailed access to the economic analysis and the database used in the EN-MSIOA Study.
- The unit rates for all irrigation projects in Sudan and Egypt were updated based on recent data that were available. As far as possible, the unit prices used for the various economic analyses are grouped together and made accessible for each irrigation scheme spread sheet. This include:
  - Additional value/gross margin (per type of benefit);
  - Selling prices;
  - Investment costs;
  - Labour cost;
  - Monetary rate;

Most of the figures used in the price schedule come from the literature. They can all be easily updated at any time as required and this will automatically change the result of the model through the dynamic links in place.

Annex 2: Calculation of Economic Indicators

Economic Net Present Value (ENPV)

The formula of the ENPV is the following :

$$NPV = \sum_{0}^{T} \frac{B_t}{(1 + r_t)^t} - \sum_{0}^{T} \frac{C_t}{(1 + r_t)^t}$$

- T design the time span, here 30 years;
- r_t is the discount rate, here 8 %;
- C_t Value of cost in year t ;
- B_t value of benefit for year t.

> The discount rate
>
> The rate is used to discount future cash flows to the present value. High rates are usually used for private investments projects. A higher rate mean that the decision maker put more preference for short terms benefits. Lower rate are usually used for the evaluation of public projects since public decision maker give less preference for short terms benefits and privileges long term benefit. But higher rates are also used to adjust for risk related to project.
>
> So, in our case study, we will use 8% for discounting rate.

NPV is an indicator of how much value a scenario adds comparing to another reference case scenario. NPV indicator should be positive for a scenario in order to be approved by the decision maker. NPV can also be used to compare scenarios. For example, if Scenario A has a higher NPV than scenario B, so the public decision maker should prefer scenario A on Scenario B.

It reflects opportunity cost of investment, rather than the possibly lower cost of capital.

Economic Internal Rate of Return (EIRR).

- The internal rate of return on a scenario is the rate of benefit expected from the scenario that makes the net present value –NPV- of all monetary flows, both positive and negative, from a particular cost equal to zero. It can be defined as the discount rate at which the present value of all future benefits and costs is equal to the initial costs.
- In more specific terms, the EIRR of a scenario is the discount rate at which the net present value of the costs of a scenario equals the net present value of the benefits of the investment.
- EIRR calculations are commonly used to evaluate the economic profitability of scenario. The higher is the EIRR of a scenario, the more profitable it is.
- Calculation of the EIRR is linked to the NPV since it is the value that make NPV equal to zero.

Cost-benefit ratio

The cost benefit ratio is also a good economic indicator that complement the previous indicators since it give an information on benefit returns on costs spent.

The formula is the following one :

$$\frac{\boldsymbol{Benefits}}{\boldsymbol{Costs}} = \frac{\sum_0^T \frac{\boldsymbol{B_t}}{(\boldsymbol{1}+\boldsymbol{r_t})^t}}{\sum_0^T \frac{\boldsymbol{C_t}}{(\boldsymbol{1}+\boldsymbol{r_t})^t}}$$

In this case, when this ratio is higher than one, it means that the sum of the benefit on the time horizon are higher than the cost. So in order to be economically acceptable, the decision maker is looking for B/C higher than one. He will also choose the scenario that has the higher ratio.