EASTERN NILE REGIONAL TECHNICAL OFFICE (ENTRO)

Integrated Watershed Management (Ethiopia)
Sub-watershed Project of Fast Track Projects
of Eastern Nile Subsidiary Action Programme

PROJECT PREPARATION REPORTS

November 2007

(In Three Volumes)

Volume III – Annexes 3 and 4

HALCROW GROUP LIMITED

METAFERIA CONSULTING ENGINEERS PLC

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Annex 3. An Assessment of Land and Water Interventions

Annex 4. Climatic Analyses and River Flows

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ANNEX 3. AN ASSESSMENT OF LAND AND WATER INTERVENTIONS

1. INTRODUCTION

This Annex presents the agricultural[1], forestry and water aspects of the proposed Integrated Watershed Management Project. It includes a description of the project areas, a review of the predominant farming systems and an assessment of possible interventions which could be adopted to improve the livelihoods of rural communities. The information presented is based on field work done in January-February, June-July and September-October 2007. It is the outcome of the participatory rural appraisal approach (PRA) to interviews, discussions and observations made with farmers, village leaders and community focus groups in five micro-watersheds of the Ribb, Gumera and Jema Rivers; both qualitative and quantitative data were collected. Similar activities were conducted with: Development Agents (DAs) in kebeles; wereda officials, particularly those in the Offices of Agricultural and Rural Development (OARDs); senior staff in the Bureau of Agricultural and Rural Development (BoARD) and the Regional Agricultural Research Institute (ARARI) in Bahir Dar; staff on research stations at Adet (crops) and Andessa (livestock); the Director of the Regional Veterinary Diagnostic Laboratory; staff of the Koga Irrigation and Watershed Management project; and staff of bi-lateral[2] and non-governmental organizations[3]. The Ministry of Water Resources in Addis Ababa and the Bureau of Water Resources in Bahir Dar helped to coordinate the field work. Literature reviews on integrated watershed management approaches and other supportive documents were undertaken to gather experience from similar studies and projects.

2. PROJECT AREAS

There are three project areas:

- The Ribb River watershed;
- The Gumera River watershed; and
- The Jema River watershed.

They are located around Lake Tana in Amhara National Regional State (ANRS) in the vicinity of 12^0 N latitude and 38^0 N longitude (Map 1). Bahir Dar is the main city of the Region. It will be the headquarters of the project. It is on the southern shore of the lake about 35 km from the lower reaches of the rivers on a main highway. The project areas were chosen by MoWR after a major study[4] which encompassed three Regional States: Amhara, Oromia and Tigray. They offer different environmental conditions and challenges within one administrative region. Geographically, the project areas fall within the Tana-Beles basin which is the beginning of the catchment of the Abbay River. Thus, for project understanding they are termed sub-catchments which collectively are termed “the gross study area”.

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[1] Agriculture (and aquaculture) are concerned with human activity systems which produce food and fibre (and many other materials) for subsistence or sale, initially by the **deliberate and controlled use (farming)** of plants and animals in either terrestrial or aquatic habitats. In this project preparation report, “aquaculture” is subsumed by the word “agriculture”, which will then include the farming of plants and animals on land and in water. In contrast, “forestry” and “fisheries” are concerned with natural systems and already created resources waiting to be protected, preserved, conserved, used, exploited or raped. This distinction is important because human activity systems could be other than they are, whereas natural systems can only be as they are.

[2] CIDA Sustainable Water Harvesting and Institutional Strengthening in Amhara (SWHISA) Project; Government of Finland Rural Water Supply and Environment Programme 4; and GTZ.

[3] Organizations for Rehabilitation and Development in Amhara (ORDA); and CARE International.

[4] King, G.J. and Gezehegn, L.K. 2005. Final Report. Selection of project areas. Watershed Management Consultancy 1: Prioritization of Fast Track Projects. Ministry of Water Resources, Federal Republic of Ethiopia and ENSAP-ENTRO.

The gross study area of 443, 659 ha (Table 1) lies in seven weredas: Libokemkem, Fogera, Farta, Dera, Estie, Mecha and Sekele. The total number of kebeles is 121 and the total population is about 0.95 million (Table 1). Population density varies between 1.95 in the Ribb River sub-catchment to 2.61 in the Jema River sub-catchment.

Table 1. Area and population statistics

	Gross area - ha	No. of villages	No. of households	Total population	Household size	Population per ha
			By sub-catchment			
Ribb	184,530	1,012	70,339	360,606	5.13	1.95
Gumera	210,332	1,220	103,167	467,319	4.53	2.17
Jema	48,797	191	24,785	127,374	5.14	2.61
			By land type			
Highland	62,252	282	39,594	154,044	3.89	2.47
Midland	322,501	1,832	137,917	688,166	4.99	2.13
Lowland	58,906	309	20,780	113,089	5.44	1.92
Total	**443,659**	**2,423**	**198,291**	**955,299**	**4.82**	**2.15**

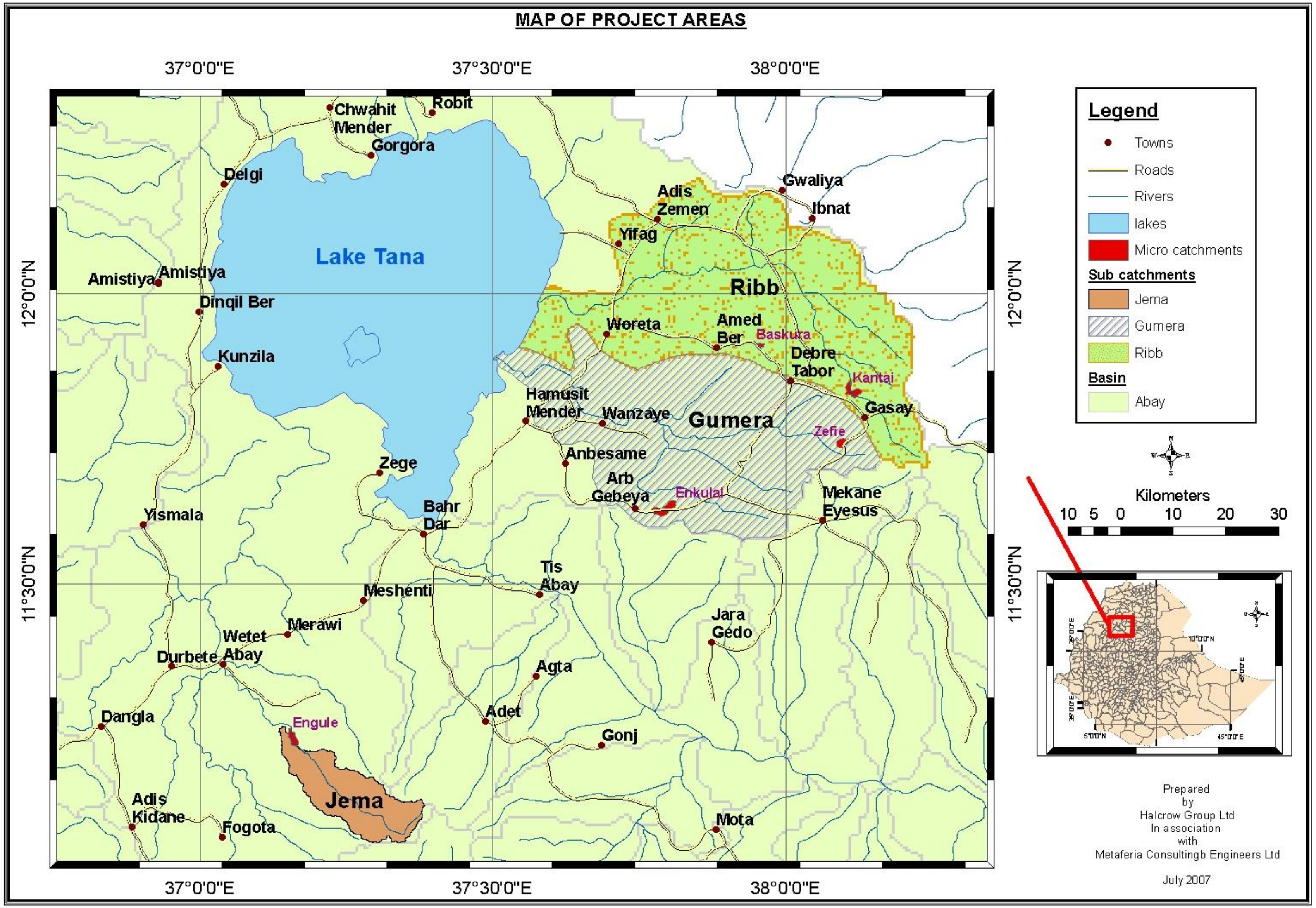
The "detailed study area" lies mainly in the highlands or upper catchments of the Ribb, Gumera and Jema Rivers. It refers to five micro-watersheds or development nuclei —Baskura, Kantai, Zefie, Enkulal and Engule—selected during the course of the project preparation for detailed assessment of resources, problems, and opportunities for development (Map 1). Each of these has been proposed as a nucleus for expansion into development clusters (Map 2) of contiguous micro-watersheds, the outflow of water from which enters the same "mainstream". The "project area" refers to the total area of these clusters to be developed under the investment project (Table 2).

Table 2. Administrative units in the sub-catchments concerned with the detailed study area and the project area

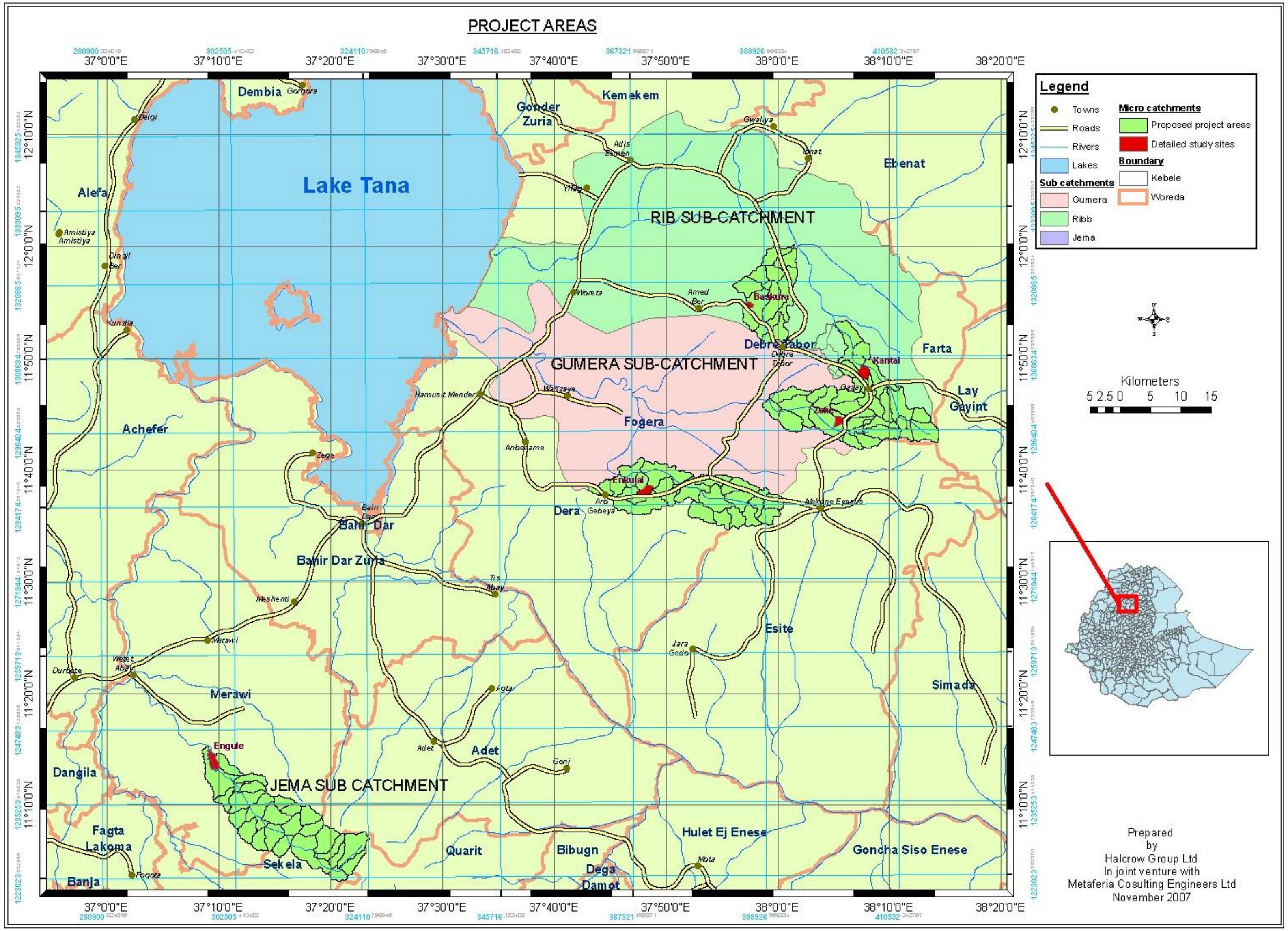
Sub-catchment	Administrative Units		Micro-watersheds	Development Nuclei	Cluster Area
	Weredas	Kebeles			ha
Ribb	Farta	12	21	Baskura	10,893
				Kantai	11,666
Gumera	Farta, Estie	13	34	Zefie	12,969
	Dera			Enkulal	19,793
Jema	Mecha, Sekele	10	27	Engule	25,279
Project area	**7**	**35**	**82**	**5**	**80, 600**

Out of the total project area of 80,600 ha, 76,708 ha will undergo some form of soil and water conservation treatment. The average area of each micro-watershed is almost 1,000 ha.

Map 1


MAP OF PROJECT AREAS
37°0'0"E
37°30'0"E
38°0'0"E
12°0'0"N
11°30'0"N
Lake Tana
Ribb
Gumera
Jema
Chwahit Mender
Robit
Gorgora
Delgi
Adis Zemen
Gwaliya
Ibnat
Yifag
Amistiya
Amistiya
Dinqil Ber
Kunzila
Woreta
Amed Ber
Baskura
Debre Tabor
Kantai
Gasay
Hamusit Mender
Wanzaye
Zefie
Anbesame
Arb Gebeya
Enkulal
Mekane Eyesus
Zege
Bahr Dar
Yismala
Tis Abay
Meshenti
Jara Gedo
Merawi
Wetet Abay
Durbete
Agta
Adet
Dangla
Engule
Gonj
Adis Kidane
Fogota
Mota
Legend
Towns
Roads
Rivers
lakes
Micro catchments
Sub catchments
Jema
Gumera
Ribb
Basin
Abay
Kilometers
10 5 0 10 20 30
Prepared
by
Halcrow Group Ltd
In association
with
Metaferia Consultingb Engineers Ltd
July 2007

Map 2


PROJECT AREAS
Lake Tana
RIB SUB-CATCHMENT
GUMERA SUB-CATCHMENT
JEMA SUB CATCHMENT
Dembia
Gonder Zuria
Kemekem
Ebenat
Alefa
Farta
Lay Gayint
Fogera
Debre Tabor
Achefer
Dera
Bahir Dar
Bahir Dar Zuria
Esite
Merawi
Simada
Adet
Dangila
Fagta Lakoma
Sekela
Quarit
Bibugn
Dega Damot
Hulet Ej Enese
Goncha Siso Enese
Banja
Legend
Towns
Roads
Rivers
Lakes
Sub catchments
Gumera
Ribb
Jema
Micro catchments
Proposed project areas
Detailed study sites
Boundary
Kebele
Woreda
Kilometers
5 2.5 0 5 10 15
Prepared by Halcrow Group Ltd In joint venture with Metaferia Cosulting Engineers Ltd November 2007

2.1 Ribb sub-catchment

The Ribb catchment ranges in **altitude** from around 1,800 m at its base to over 3,000 m in the upper catchment. **Physiographically**, the area is one of a dissected basin with high level plateau remnants separated by deeply incised rivers with steep and very steep slopes. **Rainfall** ranges from about 1,200 to >1,600 mm per year. It is uni-modal with a single secure cropping season. Most of the catchment falls into the moist weyna dega to moist dega agro-climatic zones although the highest parts of the upper catchment fall in the wet wurch and upper wurch zones.

Vegetation. The majority of the catchment has been mapped as “dominantly cultivated” and “moderately cultivated”. There are small areas of grassland in the lower basin and afro-alpine vegetation in the higher areas. A few small areas of natural woodland and some (mainly eucalyptus) plantations occur. Areas mapped as dominantly cultivated tend to correspond to less steep, middle slopes. Areas mapped as moderately cultivated are associated with steeper slopes and include a greater area of grassland and bare ground. Tree planting around homesteads is relatively common but is not common along field boundaries.

The **soils** of the Ribb catchment are primarily, moderately deep to deep chromic and haplic luvisols which are characterised by an accumulation of high activity clay minerals at some depth in the soil horizon. They are, in general, fertile soils because of their mixed mineralogy, relatively high nutrient content, and the presence of weatherable minerals. Their physical characteristics are also favourable. They are well drained (unless a dense clay accumulation layer develops over time), porous and well aerated; and they have a moderate to high moisture storage capacity. Other soils include eutric leptosols (shallow soils) in places and alluvial eutric fluvisols in the valley bottoms. The steep upper slopes of watersheds were often shallow and stony. Deeper soils were mostly associated with the less steep, middle and lower slopes. Small areas of highly fertile, but difficult to manage, vertisols and nitisols are also present.

Gullies are the most visible evidence of **soil erosion** in the Ribb catchment. They are often associated with areas of communal grazing. There is sheet erosion with exposure of rock and stones on previously-cultivated, steep, upper slopes. Given the relatively high rainfall, the safe disposal of excess runoff in the rainy season is the main priority. In-field drainage furrows, especially in teff cultivations, are a potential source of new gullies.

Soil erosion and declining soil fertility were highlighted as issues in discussions with community members during the selection of micro-watersheds and in the socio-economic studies which followed. In some areas, soil conservation structures, mainly stone bunds, are apparent. Many fields also have earth bunds marking their boundary. Both these structures are the remnants of past projects as well as farmers’ efforts to try to control erosion.

2.2 Gumera sub-catchment

The Gumera sub-catchment lies immediately south of the Ribb sub-catchment and is contiguous with it (Map 1) It ranges in **altitude** from around 1,800 m at its base to just under 3,000 m in the upper catchment. **Physiographically**, the area is similar to the Ribb, but it is less dissected with larger areas of gently-sloping, high-level, plateau remnants. **Rainfall** ranges from about 1,200 to >1,600mm per year. It is uni-modal with a single secure cropping season. Most of the catchment falls into the moist weyna dega to moist dega agro-climatic zones.

Vegetation. The majority of the sub-catchment has been mapped as “dominantly cultivated” (primarily the west and centre) and “moderately cultivated” (the centre and east). There are some small areas of grassland in valley bottoms. Other areas of grassland are associated with shallow and stony plateau crests and afro-alpine vegetation in the higher areas. Natural woodland areas are not as extensive as in Ribb, nor are eucalyptus plantations.

The **soils** of the Gumera catchment have been mapped primarily as moderately deep to deep haplic luvisols. However, large areas of very stony soils occur in the lower to middle catchment. Other soils include eutric leptosols (shallow soils) in various places and alluvial eutric fluvisols in the valley bottoms. The steep, upper slopes are often shallow and stony. Deeper soils occur on the less steep, middle and lower slopes.

Gullies associated with areas of communal grazing are the most visible evidence of **soil erosion** in the Gumera catchment. There is also sheet erosion with exposure of rock and stones on previously-cultivated, steep, upper slopes. Given the relatively high rainfall, the safe disposal of excess runoff in the rainy season is the main priority, with in-field drainage furrows noted in teff fields as future sources of gully erosion.

Soil erosion and declining soil fertility were highlighted as issues in discussions with community members during the selection of micro-watersheds and again during socio-economic studies. Fewer areas of soil conservation structures were noted compared to the Ribb catchment, although earth bunds have been constructed in some areas as part of a woreda-initiated, food security, safety net programme. Tree planting around homesteads appears to be less common than in the Ribb. It is also not as common along field boundaries.

2.3 Jema sub-catchment

The Jema River joins the Gilgel/Abbay at Wetet Abbay, about 15km south of Merawi by sealed road. However, access within the catchment is extremely poor. Therefore, road construction must be the primary intervention to underpin any other interventions. In the adjoining Koga catchment to the north, a dam is being built as part of an irrigation development project with watershed management in its upper catchment. This project is funded by the African Development Bank.

The sub-catchment ranges in **altitude** from around 2,000m in the north, where it joins the Gilgel-Abbay, to 3,000 m in the upper watersheds of the south. **Physiographically**, the northern area is relatively flat with most slopes less than 10%. The southern area is more typical of the Ethiopian highlands with rolling to steep topography and slopes of 15-30%. At around 1,700 mm per year, **rainfall** is slightly higher than that in the Ribb and Gumera sub-catchments. It is uni-modal with a single secure cropping season. The northern area falls in the wet weyna dega zone of the traditional agro-climatic classification whilst the southern area is in the wet dega zone.

Vegetation. The northern area has been mapped as “dominantly cultivated”. Patches of natural woodland occur on hill crests and eucalyptus plantations are common around homesteads, in gullies and watercourses, and occasionally as field boundaries. The southern area is “moderately cultivated” with eucalyptus forests occurring on steeper slopes. Generally, the sub-catchment is more wooded than the Ribb and Gumera catchments.

The **soils** have been mapped as primarily haplic alisols with small areas of haplic luvisols in the lower catchment. Alisols are generally deep friable soils but are not as fertile as luvisols, being more acidic, often with high amounts of aluminium in the subsoil. They are also more prone to erosion than luvisols since the friable topsoil has low structural stability. Smaller areas of more fertile eutric nitisols and eutric vertisols have also been mapped. Many hill crests and upper slopes are extremely stony and/or shallow with areas of bare rock.

Gullies associated with areas of communal grazing are the most visible evidence of **soil erosion** in the northern area of the sub-catchment. There is sheet erosion, with exposure of rock and stones, on previously-cultivated, steep, upper slopes. Given the relatively high rainfall, the safe disposal of excess runoff in the rainy season is the main priority with in-field drainage furrows noted in some fields.

Low yields and a lack of fertilizer rather than soil erosion were highlighted as issues in discussions with community members during the selection of micro-watersheds and in subsequent visits. There were fewer areas with soil conservation structures compared to the Ribb and Gumera catchments, although most fields were bounded by earth bunds and many were planted with eucalyptus.

Wood and charcoal are exported by donkey to market at Merawi, but dung usage as fuel is high. This suggests that the returns to fuelwood are greater than those obtainable from selling crop surpluses which could be produced by using dung as manure.

2.4 Study sites

Within each development nucleus, a detailed study site was chosen which incorporated at least one cohesive social unit within areas up to about 400 ha (Table 3). On average, a study site was about one third of the individual micro-watershed (nucleus) area. The planned project implementation methodology of Participatory Land Use Plans (PLUPs) followed by participatory development of Community Action Plans (CAPs) was tested in these sites.

Table 3. Location of development nuclei study site areas

Catchment	Nucleus	Location	Wereda	Kebele	Study site ha
Ribb	Baskura	10km W of Debre Tabor	Farta	Koley Dengors	137
	Kantai	3km W of Gasay	Farta	Jura	384
Gumera	Zefie	3km S of Gasay	Farta	Menet	229
	Enkulal	34km E of Anbesame	Dera	Galwedewose	350
Jema	Engule	22km S of Merawi	Mecha	Lehulum Selam	319

The characteristics of the study sites within the five nucleus micro-watersheds are indicated in Table 4.

Table 4. Land use in the study sites.

Catchment	Nucleus	Altitude	Agro-climatic zone	Percentage Land Use			
		m (a.m.s.l.)		Cultivated	Grazing	Eroded	Forest
Ribb	Baskura	2,315	Moist Weyna Dega/Dega	60	32	6	2
	Kantai	2,780	Moist Dega	63	17	16	4
Gumera	Zefie	2,855	Moist Dega	64	16	15	5
	Enkulal	2,390	Moist Dega	63	16	16	5
Jema	Engule	2,045	Moist Weyna Dega	61	31	6	2

2.4.1 Baskura (Map 3 and Plate 1)

The Baskura micro-watershed has a relatively large area of communal grazing land in the centre of the area which shows evidence of overgrazing and gullying. Upslope of this, the headwaters of the Baskura stream have been treated with gabions and check-dams as part of a GTZ demonstration project. Steep slopes to the south of the road are terraced and cultivated. Land to the north of the road is also cultivated. An area of enclosed and fenced regeneration forest occurs in the west of the micro-watershed. Soil and water management is the priority sector for the community after highlighting erosion and land degradation problems during preparatory work for a Community Action Plan.

2.4.2 Kantai (Map 4 and Plate 2)

The Kantai micro-watershed has severely eroded 'badlands' which are now used as grazing lands: they were arable 30 years ago. These badland areas generate runoff that is concentrated into gullies that are actively eroding arable land downslope. The community has recently introduced stone terracing into areas of arable land on gentle slopes. Soil and water management is the priority sector for the community after highlighting erosion and land degradation problems during preparatory work for a community Action Plan.

2.4.3 Zefie (Map 4 and Plate 3)

The Zefie micro-watershed comprises a series of steep basalt ridges which cut across the area interspersed by intensively cultivated flatter areas. The northern boundary is a severely eroded ridge separating it from surrounding micro-watersheds but the western and eastern boundaries are social boundaries demarcated by streams.

This severely eroded ridge was also arable land in the past and it was part of a GTZ rehabilitation project. However, the bunds were destroyed by the community who felt it had been imposed on them. As in other micro-watersheds, soil and water management is the priority sector for the community, highlighting erosion and land degradation problems.

2.4.4 Enkulal (Map 5 and Plate 4)

The Enkulal micro-watershed is characterised both by a stand of dense natural forest forming the border of the upper catchment and areas of severely eroded 'badlands' where the topsoil has been stripped down to bedrock. This area corresponds to areas of communal grazing lands although it was cultivated in the recent past (10-15 years ago) and was forested up to 1975. Other areas of erosion with active gullies also occur on the eastern slopes.

Many cultivated areas have been recently bunded with soil and stone bunds but soil and water management is still the priority sector for the community with particular emphasis on the rehabilitation and prevention of further encroachment of the severely eroded areas.

2.4.5 Engule (Map 6 and Plate 5)

The Engule micro-watershed comprises wooded, rocky and stony hills forming the upper slopes of the eastern boundary, a large area of arable land on gently undulating terrain towards the Jema River, and severe gully erosion associated with areas of communal grazing in the north-east of the area. The runoff from the hills is channelled into gullies which are a problem to the community. Flooding and river bank erosion are also indicated as priority constraints.

However, in contrast to the other micro-watersheds, access is the priority sector for the community indicating the area's relative inaccessibility. Soil and water management is the second priority for the community, with erosion and land degradation problems. In addition, Engule is the only micro-watershed where the community remains to be convinced of the project's aims, citing land requisition and resettlement associated with Koga Dam as worries.

Map 3

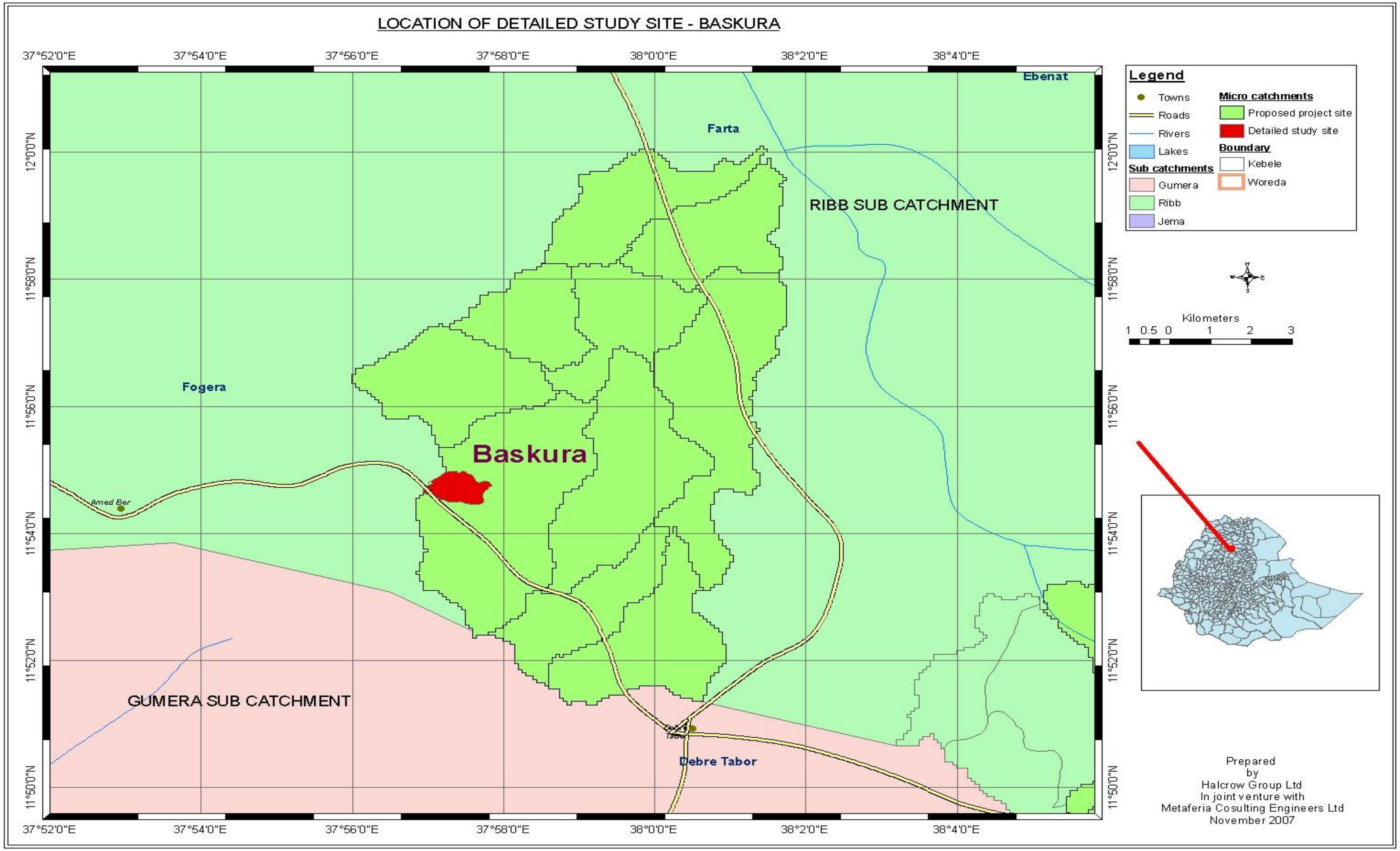

LOCATION OF DETAILED STUDY SITE - BASKURA
Legend
Towns
Roads
Rivers
Lakes
Sub catchments
Gumera
Ribb
Jema
Micro catchments
Proposed project site
Detailed study site
Boundary
Kebele
Woreda
Kilometers
1 0.5 0 1 2 3
Ebenat
Farta
Fogera
Baskura
Amed Ber
RIBB SUB CATCHMENT
GUMERA SUB CATCHMENT
Debre Tabor
37°52'0"E
37°54'0"E
37°56'0"E
37°58'0"E
38°0'0"E
38°2'0"E
38°4'0"E
12°0'0"N
11°58'0"N
11°56'0"N
11°54'0"N
11°52'0"N
11°50'0"N
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Plate 1

RIBB WATERSHED

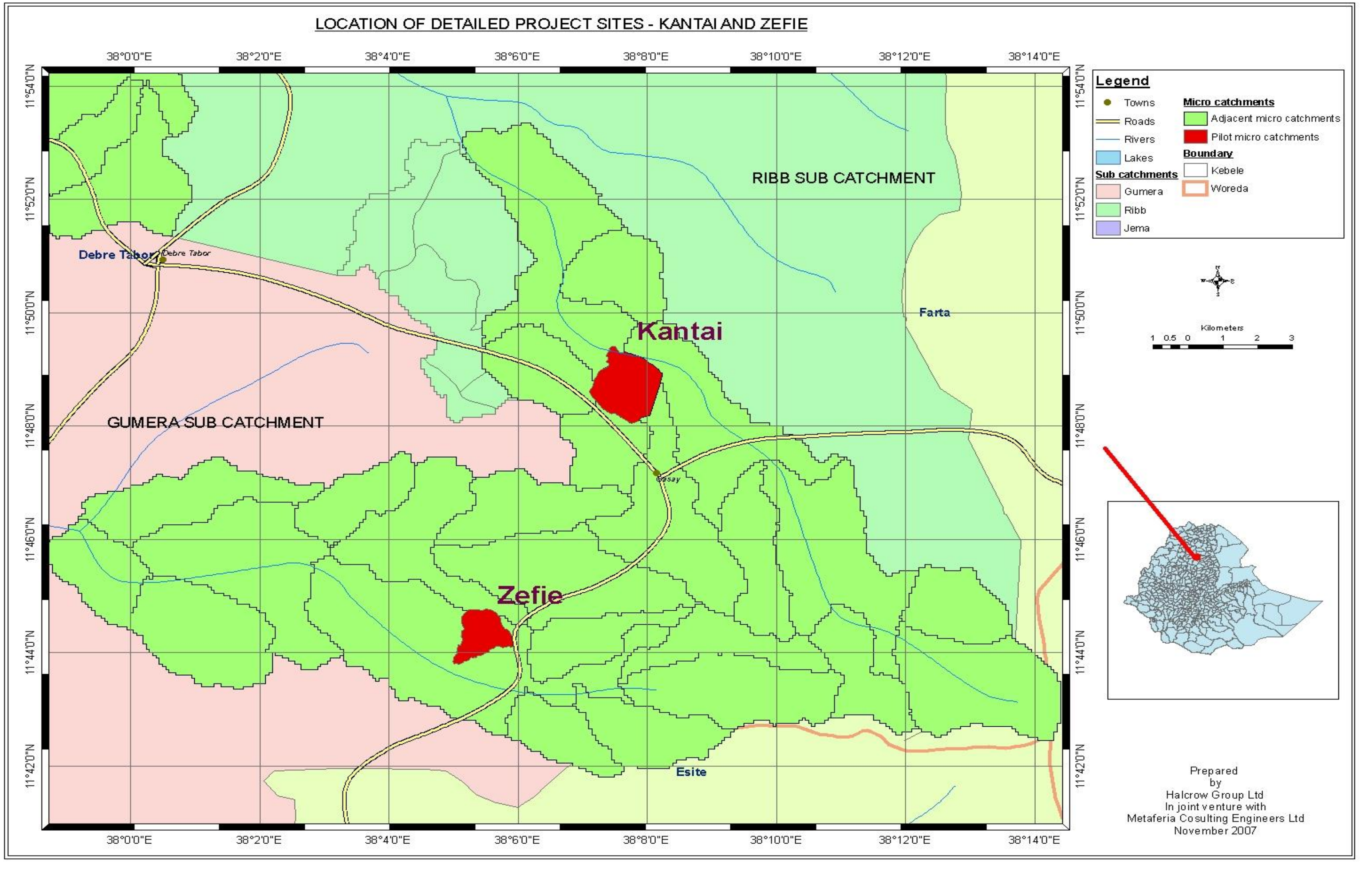
Baskura Micro-Watershed


Very steep slopes used for grazing and cultivation in middle part of micro-watershed


Seriously degraded communal grazing land in upper part of micro-watershed


Seriously degraded communal grazing land with gully and a FINNIDA-funded potable water supply system

Map 4



LOCATION OF DETAILED PROJECT SITES - KANTAI AND ZEFIE
Legend
Towns
Roads
Rivers
Lakes
Sub catchments
Gumera
Ribb
Jema
Micro catchments
Adjacent micro catchments
Pilot micro catchments
Boundary
Kebele
Woreda
RIBB SUB CATCHMENT
GUMERA SUB CATCHMENT
Debre Tabor
Kantai
Zefie
Farta
Esite
Kilometers
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Plate 2

Kantai Micro-Watershed


Cultivated land in middle and lower part of micro-watershed. Degraded cultivable land in upper part of micro-watershed


Gully in middle part of micro-watershed. Degraded arable land in upper part of micro-watershed.

GUMERA WATERSHED

Plate 3

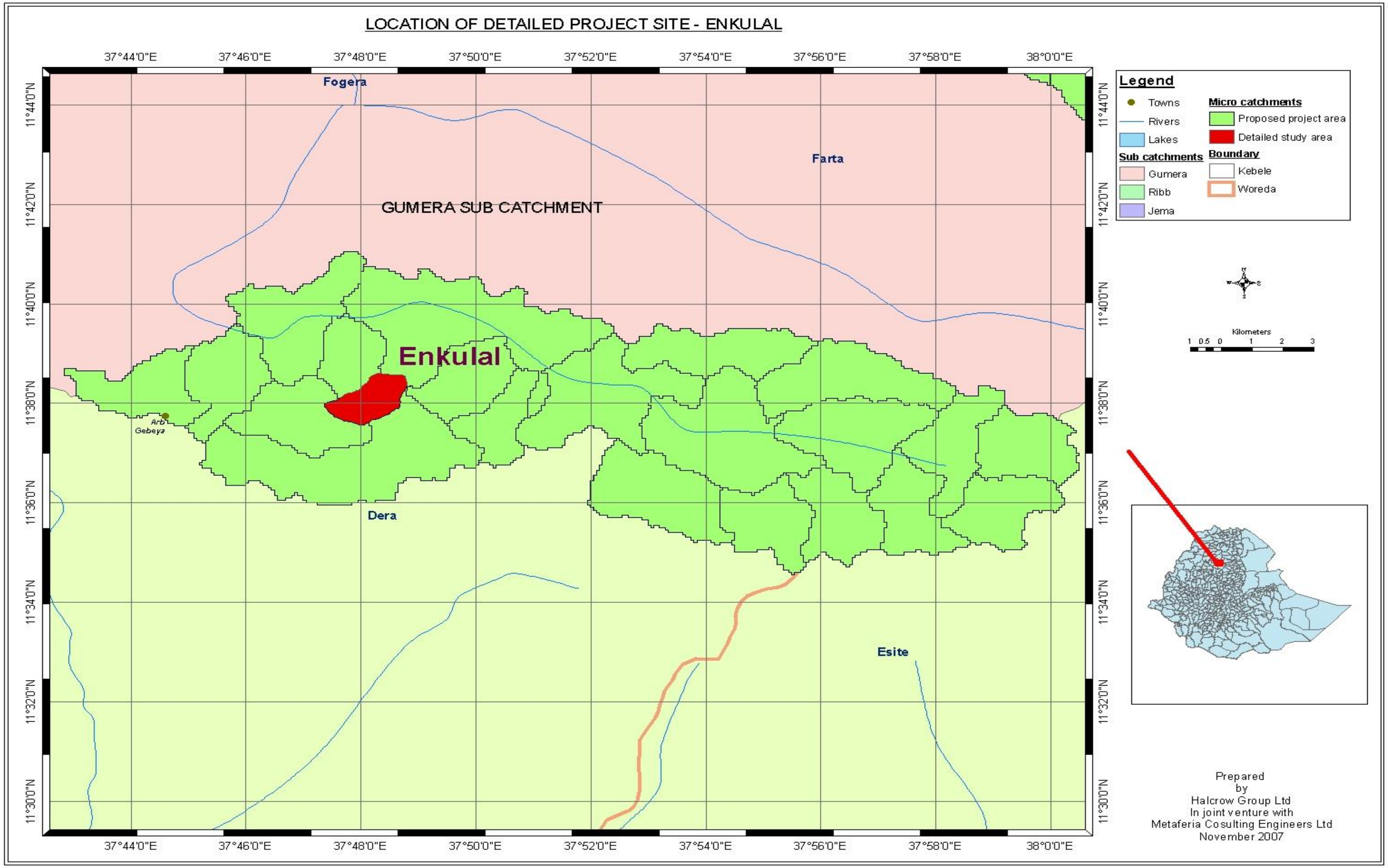
Zefie Micro-Watershed


Arable land in middle and lower part of micro-watershed


Degraded arable land in upper part of micro-watershed


Seriously degraded land in upper part of micro-watershed

Map 5


LOCATION OF DETAILED PROJECT SITE - ENKULAL
37°44'0"E
37°46'0"E
37°48'0"E
37°50'0"E
37°52'0"E
37°54'0"E
37°56'0"E
37°58'0"E
38°0'0"E
11°44'0"N
11°42'0"N
11°40'0"N
11°38'0"N
11°36'0"N
11°34'0"N
11°32'0"N
11°30'0"N
Fogera
Farta
GUMERA SUB CATCHMENT
Enkulal
Arb Gebeya
Dera
Esite
Legend
Towns
Rivers
Lakes
Sub catchments
Gumera
Ribb
Jema
Micro catchments
Proposed project area
Detailed study area
Boundary
Kebele
Woreda
Kilometers
1 0.5 0 1 2 3
Prepared
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November 2007

GUMERA WATERSHED

Plate 4

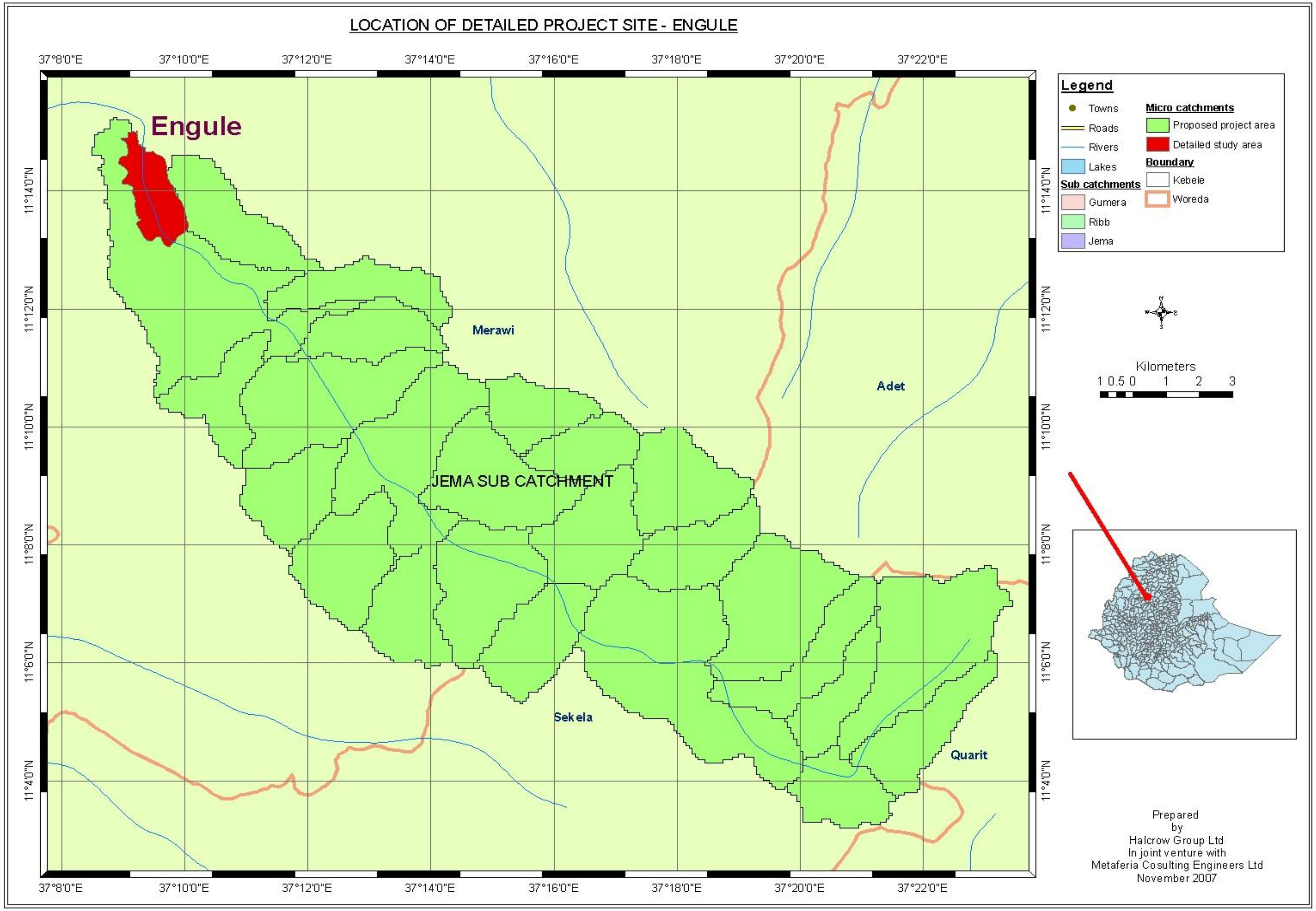
Enkulal Micro-Watershed


Protected Forest in upper part of micro-watershed


Seriously degraded communal grazing land in upper part of micro-watershed


Seriously degraded communal grazing land in upper and middle part of micro-watershed

Map 6


LOCATION OF DETAILED PROJECT SITE - ENGULE
Engule
Merawi
Adet
JEMA SUB CATCHMENT
Sekela
Quarit
Legend
Towns
Roads
Rivers
Lakes
Sub catchments
Gumera
Ribb
Jema
Micro catchments
Proposed project area
Detailed study area
Boundary
Kebele
Woreda
Kilometers
1 0.5 0 1 2 3
37°8'0"E
37°10'0"E
37°12'0"E
37°14'0"E
37°16'0"E
37°18'0"E
37°20'0"E
37°22'0"E
11°14'0"N
11°12'0"N
11°10'0"N
11°8'0"N
11°6'0"N
11°4'0"N
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November 2007

JEMA WATERSHED

Plate 5

Engule Micro-Watershed


Lower part of micro-watershed along Jama River


Community-managed forest in upper part of micro-watershed. Serious gully forming between arable land in middle part.


Arable land along Jama River with lift irrigation potential and river bank erosion.

3. NATURAL RESOURCES

3.1 Climate

Ethiopia lies between latitude 3^0 N and 15^0 N and longitude 33^0E and 48^0E. Much of the country (about 44%) consists of mostly moist to wet highland areas lying above 1,500 m and rising to about 4,600 m. The rest can be categorized as moist lowland (below 1500m) and dry lowland. This primary division is classified further for agricultural purposes in Table 5. The project areas lie in the Weyna Dega to Wurch agro-climatic zones.

The major factor influencing rainfall is the inter-tropical convergence zone (ITCZ). Its northward movement develops a short rainy season (Belg) in some parts of the country. The south-west monsoon is dominant in June-July: the main rainy season (Keremt) commences then in most parts of the country. In the highlands, altitude and aspect influence the precise agro-climatic conditions within the micro-watersheds. Table 6 shows the average monthly distribution of rainfall and temperature for Debre Tabor which lies on the ridge between the Ribb and Gumera watersheds about 10 km east of Baskura micro-watershed. Table 7 shows data for Gasay, another 16 km east of Debre Tabor and near Kantai and Zefie micro-watersheds. Table 8 shows data for Arb Gebeya (1,800 m a.m.s.l) which is near the highest area (2,490 m a.m.s.l) in Enkulal micro-watershed in the Gumera watershed. From these data it is clear that the growing season for annual crops within these two watersheds varies significantly from 90 to 210 days. Furthermore, highly variable rainfall in March and November can add another two months to the useful growing season for perennial pastures and tree crops. Temperatures do not restrict growth.

Table 5. Agro-climatic zones as understood in Ethiopia

Zone	Sub-zone	Altitude a.m.s.l	Rainfall	Temperature	Growing season
		m	mm/year	°C av/year	days
Bereha	Dry	<500	<200	>27	<45
Kolla	Dry	500	200	27	60
	Moist	1,500	800	21	90
Weyna Dega	Dry	1,500	800	21	90
	Moist	2,300	1,200	16	150
Dega	Moist	2,300	1,200	16	150
	Wet	3,000	2,200	11	180
Wurch	Moist	3,000	>1,400	11	150-180
	Wet	3,700	>2,200	7	211-270
High Wurch	Wet	>3,700	>2,200	<7	

Sources: de Paw, 1989 and MoARD, 2000.

Table 6. Average monthly rainfall (n=18) and temperature (n=12) for Debre Tabor (1985-2004, 1990-91 missing)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Average rainfall - mm	5	5	34	47	94	165	402	393	181	83	24	14	1,445
Range: Maximum	35	38	86	118	204	352	592	629	249	251	76	83	629 to 35
Minimum	0	0	0	7	6	73	257	260	60	3	0	0	260 to 0
Av. Temperature - ^{o}C	14	15	16	16	16	15	13	13	14	14	14	14	14
Range: Mean max.	23	24	25	24	24	22	19	19	20	21	22	22	22
Mean min.	8	9	10	11	11	10	10	10	9	9	8	8	10

Table 7. Average monthly rainfall (n=8) and temperature (n=5) for Gasay (1977-81, 2004-06)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Average rainfall - mm	6	6	27	50	84	150	395	345	180	84	27	13	1,369
Range: Maximum	20	18	64	147	208	221	474	468	548	229	74	32	548 to18
Minimum	0	0	5	0	7	73	309	232	78	26	0	0	309 to 0
Av. Temperature - ^{o}C	14	15	15	15	15	14	13	13	13	13	13	13	14
Range: Mean max.	20	21	22	22	21	20	18	18	19	20	21	20	20
Mean min.	6	6	7	7	7	7	7	6	6	5	4	4	6

Table 8. Average monthly rainfall (n=7) and temperature (synthesized) for Arb Gebeya (1998-2004)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Average rainfall - mm	16	10	44	50	24	42	256	251	60	27	13	12	843
Range: Maximum	55	18	80	78	60	75	360	346	79	83	62	27	360 to 18
Minimum	0	0	1	20	0	16	170	169	23	0	0	0	170to 0
Av. Temperature - ^{o}C	20	20	21	21	21	21	19	18	19	19	18	19	20
Range: Mean max.	32	31	32	31	30	29	26	26	27	28	29	30	29
Mean min.	10	11	12	13	13	13	12	13	12	11	10	9	12

3.2 Topography and soils

The topography of the highlands is very complex ranging from steep, deeply dissected river gorges and broad valleys to moderately steep gently rolling foothills and extensive highlands including plains of medium altitudes. In the project areas, the upper catchments of the Ribb and Gumera watersheds are quite similar with only small areas of gently rolling foothills in contrast to the upper catchments of the Jema watershed which combines steep country with flat lands.

In most areas, the soils were relatively deep and fertile on the lower slopes of the highlands. This made them very suitable for crop production. However, soil erosion has led to the loss of fertile topsoil and a reduction in crop yields.

However, no chemical analysis data were available for use in this report to assess the claim that soil fertility had declined. Moreover, there was no data on which to base fertilizer recommendations for crop growth and nutrient requirements for animals according to soil type and existing fertility levels. Blanket recommendations of only two fertilizers, diammonium phosphate (DAP) and urea, are in use. This is a serious flaw in the information system which must be rectified if the improvement of crop and animal productivity is to be placed on a sound foundation.

3.3 Natural vegetation

Most of the natural forest areas found during the reconnaissance field visits were afforded the status of a protected forest area for the purposes of biodiversity and conservation by the weredas. However, their status was unclear at the Regional State level where they are classified as priority forest areas. Currently, they are not well covered institutionally by either BoARD or EPLAUA due to the recent re-organisation of responsibilities between the two Bureaus.

The importance of these areas of high bio-diversity, and cultural significance as sources of non-timber forest products (NTFPs), has been taken into account in project design which incorporates improved management and enrichment planting for the areas. This is particularly the case for eroded areas. They need to be integrated, protected and enhanced in the project implementation process. This assumes, of course, that project communities will support the approach in their CAPs.

The natural vegetation in Jema watershed is heavily degraded due to wanton cutting, overgrazing and opening the land for cropping. Remnants of the vegetation cover include scattered trees and patches of shrubs and bushes on hills and mountain slopes and along streams. Grasses also occur with bushes and shrubs, around homesteads, on pasture lands, on field boundaries and along narrow valleys. Scattered natural trees are common within homesteads, in crop fields and along streams as traditional agro-forestry species.

Remnants of natural woody vegetation in the Mecha wereda are *Croton macrostachys, Cordia abyssinica, Podocarpus falcatus, Juniperus procera, Hagenia abyssinica, Carisa edulis, Ficus spp., Cheba (Am*[Am]*) and Dokma (Am).* In Sekela wereda, additional species are: *Arundinaria alpina, Erica arboria, Hypericum revolutum, Hagenia abyssinica, Sholla (Am), Wolkifa (Am), Aluma (Am), Tikurenchet (Am) and Dong (Am). Erica arboria and Arundinaria alpina (bamboo)* are good indicators of cold climate.

These remnants of the natural vegetation in communal lands are protected by forest protection committees in Kebele Administrations (KAs). They are guarded by local farmers who are allowed to use dry wood, branches of trees, and grasses as fees for their services.

[Am] = Amharic

There are non-contiguous areas of remnant natural forest in other Project areas. They are high in bio-diversity in comparison to plantations of eucalyptus. These are not indigenous and have very low levels of biodiversity. The forest remnants are havens for wildlife and birdlife, and they are biodiversity reserves for flora. They also play an important role in providing the local communities with natural medicines, NTFPs and other cultural amenities. The forest areas are not large: the largest found was about 1,000ha, but most areas are much smaller.

Plate 6. An area of natural forest showing very high biodiversity

Plate 7. One of the larger areas of natural forest in the project area covering about 1,000ha

Plate 8. Forest areas are also havens for wild life

Plate 9. An unidentified indigenous species. It was found to be carrying at least 15 species of orchid, whereas Eucalyptus spp. have none.

Other work should include a forest inventory and a management approach which includes using indigenous species which support the rich fauna and flora that is evident in the watershed. As the areas of natural forest are significant in terms of biodiversity this aspect will need to be reviewed in more detail during the CAP process and the project financing process in terms of the resources needed.

3.3.1 Ribb and Gumera watersheds

Other species of natural woody vegetation found in crop fields, grazing areas and forest remnants in the Ribb and Gumera watersheds are: *Acacia albida, Albizia gummifera, Comberetum spp., Olea Africana, Rosa abyssinica,* Birbira (Am), Lol (Am), Imbus (Am), Shilet (Am), and Shinshua (Am). Some other important shrubby species are: *Dodonia viscose*, *Ecuclea shemperi*, Atat (Am) and Kechemo (Am).

It is from these species that enrichment plantings of forest remnants will be undertaken by the project as well as new plantings to stabilize the steepest slopes and worst gullies.

4. SOIL AND WATER MANAGEMENT

4.1 Land Use Classification in the Study Sites

The following charts give details of the different land development classes identified during the PLUP exercise undertaken within the five study sites. The problems associated with each land capability class are listed and the suggested interventions to be introduced for improved soil and water management described. Actual interventions will be determined during the CAP process.

Land use: C = cultivation; E = badlands; F = forestry; G = grazing

Slope: 1 = <8%; 2 = >8%<15%; 3 = >15%<30%; 4 = >30%<60%; 5 = >60%

Baskura micro-watershed

Land Development Class	Suitable Interventions
C1 **<u>Description</u>** Arable land with homesteads in east of micro-watershed. Cultivated land (wheat, barley, teff, maize, noug) without bunding on slopes of 0-8%. Eucalyptus and hedgerows planted around homesteads only. LCC III **<u>Current Problems</u>** Sheet wash on arable land. Declining soil fertility and yields **Area:** 22.6ha **Costing Category:** 1c	**<u>Possible solutions</u>** To retain moisture on arable areas – **soil bunds at field boundaries** To improve soil fertility and provide bund stability - **soil fertility management and hedgerow planting**
C2 **<u>Description</u>** Arable land with homesteads in east of micro-watershed. Cultivated land (wheat, barley, teff, maize, noug) without bunding on slopes of 8-15%. Eucalyptus and hedgerows planted around homesteads only. LCC III **<u>Current Problems</u>** Sheet wash on arable land. Declining soil fertility and yields **Area:** 23.5ha **Costing Category:** 2c	**<u>Possible solutions</u>** To retain moisture on arable areas – **soil bunds at field boundaries** To improve soil fertility and provide bund stability - **soil fertility management and hedgerow planting** **<u>Note</u>** Potential for small-scale irrigation should be investigated
C3 **<u>Description</u>** Arable land and homesteads in east of micro-watershed. Cultivated land (wheat, barley, teff, maize, noug) with terracing/bunding on slopes of 15-30%. Eucalyptus and hedgerows planted in homestead area. LCC IVl **<u>Current Problems</u>** Steep slopes and moderately deep soils only. Declining soil fertility. **Area:** 31.2ha **Costing Category:** 3c	**<u>Possible solutions</u>** To retain moisture on arable areas – **rehabilitation/improvement of stone (or stone-faced) bunds** To improve soil fertility and provide bund stability - **soil fertility management and hedgerow planting** To prevent further gully erosion – **stone and brushwood check-dams, gully re-vegetation**

C4 **<u>Description</u>** Downslope of G4. Cultivated land (wheat, barley) with terracing on slopes of 30-60%. Gullying in watercourses. LCC VII **<u>Current Problems</u>** Steep slopes and moderately deep soils only. Declining soil fertility and yields, sheet wash **Area:** 5.5ha **Costing Category:** 4c	**<u>Possible solutions</u>** To retain moisture on arable areas – **rehabilitation/improvement of bench terraces with vetiver hedgerows** To prevent further gully erosion – **stone and brushwood check-dams, gully re-vegetation** **<u>Notes</u>** Check dams and some re-vegetation already undertaken in small gullies. Costs of terracing will be lower since rehabilitation rather than overall construction required
G2 **<u>Description</u>** Communal grazing land, bisected by Baskura stream, in centre of area. Shallow (with rock outcrops) to moderately deep soils. Slopes 0-15%. Gully/streambank erosion on main stream and incipient gullying. LCC IVd **<u>Current Problems</u>** Sheetwash into stream, gullying, declining soil fertility lowering carrying capacity **Area:** 16.6ha **Costing Category:** 2g & 2e	**<u>Possible solutions</u>** To improve soil fertility and carrying capacity whilst retaining moisture – **grass strips initially with improved pasture between grass strips. Once established grass strips can be converted to hedgerows with fodder crops.** To prevent further gully erosion – **stone and brushwood check-dams, gully re-vegetation** **<u>Note</u>** Shallow fragile soils, therefore no soil bunding. Small stone bunds may help grass strip establishment. Rotating area closure may be needed to establish grass strips and improved pasture.
G3 **<u>Description</u>** Communal grazing land upslope of G1. Shallow (with rock outcrops) to moderately deep soils. Slopes 15-30%. LCC VII **<u>Current Problems</u>** Sheetwash and declining soil fertility lowering carrying capacity **Area:** 18.5ha **Costing Category:** 3g & 3e	**<u>Possible solutions</u>** To improve soil fertility and carrying capacity whilst retaining moisture – **rotating area closure, establishment of grass strips initially with improved pasture between grass strips. Once established, grass strips can be converted to hedgerows with fodder crops.** **<u>Note</u>** Shallow fragile soils, therefore no soil bunding. Small stone bunds may help grass strip establishment. Rotating area closure may be needed to establish grass strips and improved pasture.

G4 **<u>Description</u>** Southern boundary. Steep degraded slopes. Generally shallow and stony soils. Shrub and grassland vegetation. Slopes 30-60%. LCC VIId **<u>Current Problems</u>** Low infiltration and sheet erosion. Runoff is concentrated into gullies and washes over downslope arable lands. **Area:** 3.8ha **Costing Category:** 4g &4e	**<u>Possible solutions</u>** To retain moisture on slopes – **area closure and forestry** To protect sheet wash onto arable land – **cut-off drains** To prevent further gully erosion – **stone and brushwood check-dams, gully re-vegetation** **<u>Notes</u>** Check dams and some re-vegetation already undertaken in small gullies Cut-off drains constructed in places
F4 **<u>Description</u>** Northwestern boundary. Replanted, formerly deforested area. Fenced and closed for re-vegetation. Slopes 30-60% LCC IVe **<u>Current Problems</u>** Moderately eroded when stripped of forest cover in past. Now replanted and fenced for protection. **Area:** 2.5ha **Costing Category:** 4f	**<u>Possible solutions</u>** None required – area is closed and replanted to indigenous vegetation according to local knowledge.
Community development Investigate possibilities of such interventions as roof water harvesting, spring development, conservation tillage etc	**Soil fertility management & biological soil conservation** **Bund stabilisation using grasses and legumes; contour ploughing and composting, cash crops along bunds; control grazing in bunded areas.**

Kantai Micro-watershed

Land Development Category	Suitable Interventions
C1 &C2 **<u>Description</u>** Arable land (wheat, barley, teff, maize, noug) on shallow to moderate slopes (0-15%) south of Kantai river. Moderately deep to deep soils with some stones. Stone bunds constructed in last 5 years in north of area. Eucalyptus and hedgerows planted around homesteads only. LCC IIIl **<u>Current Problems</u>** Sheetwash on arable land. Declining soil fertility and yields **Area:** 95.7ha **Costing Category:** 1c & 2c	**<u>Possible solutions</u>** To retain moisture on arable areas and reduce sheetwash **– leguminous hedgerows on top of soil bunds along contour possibly alternating with grass strips** To improve soil fertility and provide bund stability - **soil fertility management (compost promotion) and multi-purpose tree, shrub and grass planting along bunds** **<u>Note</u>** Community have suggested a study of the area's soils to improve appropriate fertiliser use. Main fertilisers used are DAP and urea which may not be the most suitable.
C3 **<u>Description</u>** Arable land (wheat, barley, teff, maize, noug) on steeper slopes (15-30%) north of Kantai river. Shallow to moderately deep and deep soils with some stones. Stone bunds constructed but need rehabilitation. Eucalyptus and hedgerows planted around homesteads only. LCC IVl **<u>Current Problems</u>** Sheetwash on arable land. Declining soil fertility and yields **Area:** 70ha **Costing Category:** 3c	**<u>Possible solutions</u>** To retain moisture on arable areas and reduce sheetwash – **stone bunds along contour possibly alternating with grass strips in areas of lower slope** To improve soil fertility and provide bund stability - **soil fertility management (compost promotion) and multipurpose tree, shrub and grass planting along bunds**
G1 **<u>Description</u>** Grazing land close to watercourses. Moderately deep to deep soils, waterlogged in rainy season. Slopes 0-8%. LCC IVw **<u>Current Problems</u>** Overgrazing, declining soil fertility lowering carrying capacity **Area:** 21ha **Costing Category:** 1g	**<u>Possible solutions</u>** Establishment of improved pasture – rotating area closure to enable pasture to establish
G2 **<u>Description</u>** Areas formerly used as arable land but now eroded and converted to grazing land. Shallow to moderately deep but often stony soils. Evidence of former stone bunding. Slopes 8-15%. LCC VIIe **<u>Current Problems</u>** Overgrazing and sheet erosion. **Area:** 25ha **Costing Category:** 2g	**<u>Possible solutions</u>** Area closure and conversion to cut-and-carry feeding or establishment of silvi-pasture (fodder crops/trees) and/or forestry. May need to rotate areas closed during establishment to provide some grazing land. Old stone bunds may be used as boundary markers.

G3 **<u>Description</u>** Steep (15-30%) slopes to river. Shallow to stony soils. LCC VIId **<u>Current Problems</u>** Overgrazing and sheet erosion. **Area:** 19ha **Costing Category:** 3g	**<u>Possible solutions</u>** Area closure with leguminous hedgerows and possible conversion to forestry and/or silvi-pasture (fodder crops/trees). May need micro-basins to establish trees.
G4 **<u>Description</u>** Steep (30-60%) slopes to river. Shallow to stony soils. LCC VIId **<u>Current Problems</u>** Overgrazing and sheet erosion. **Area:** 2ha **Costing Category:** 4g	**<u>Possible solutions</u>** Area closure and conversion to forestry and/or silvi-pasture (fodder crops/trees). With cut-off drain. May need micro-basins to establish trees.
E2 **<u>Description</u>** Severely eroded area within arable land. Shallow to moderately deep stony soils. LCC VIIe **<u>Current Problems</u>** Severe sheet erosion with runoff onto arable land. **Area:** 41ha **Costing Category:** 2e	**<u>Possible solutions</u>** Area closure and conversion to forestry and/or silvi-pasture (fodder crops/trees). **<u>Notes</u>** Community gully stabilisation measures ineffective. Cut-off drain exacerbates gully erosion.
E3 **<u>Description</u>** Severely eroded crests and upper slopes. Shallow to moderately deep stony soils, extremely hard and cemented when dry but which disassociate on contact with water. Active gully erosion into these soils. Area was arable land 30 years ago but converted to grazing land due to erosion. LCC VIIIe **<u>Current Problems</u>** Severe sheet and gully erosion **Area:** 13ha **Costing Category:** 3e	**<u>Possible solutions</u>** Area closure with cut and carry and conversion to forestry and/or silvi-pasture (fodder crops/trees). Community suggest rotation of area closure to retain some land for grazing. To protect sheetwash onto arable land and to channel runoff to suitable channel – **cut-off drains** To prevent further gully erosion – **brushwood check-dams and gully revegetation. Stone check-dams not recommended due to soil characteristics.**
F4 **<u>Description</u>** Eucalyptus plantation. Shallow to moderately deep stony soils. LCC IVl **<u>Current Problems</u>** Euclyptus monoculture **Area:** 16ha **Costing Category:** 4f	**<u>Possible solutions</u>** Land closure and enrichment planting with indigenous tree species
Community development. Investigate possibilities of such interventions as roofwater harvesting, spring development, conservation tillage etc Soil testing to improve appropriate fertiliser use and to enable suitable gully re-vegetation and stabilisation.	**Soil Fertility management & Biological Soil Conservation** **Bund stabilisation using grasses and legumes; contour ploughing and composting, cash crops along bunds; control grazing in bunded areas.**

Zefie Micro-watershed

Land Development Category	Suitable Interventions
C1 **<u>Description</u>** Cultivated land between basalt escarpments. Moderately deep stony soils with some stone bunds. Most fertile soils in area according to community LCC IVd **<u>Current Problems</u>** Declining soil fertility, some sheet erosion. **Area:** 24.3ha **Costing Category:** 1c	**<u>Possible solutions</u>** To retain moisture on arable areas – **grass strips along the top of soil bunds** To improve soil fertility and provide bund stability - **soil fertility management and hedgerow planting, replacement of eucalyptus with multi-purpose hedgerow species**
C2 **<u>Description</u>** Arable land with homesteads in upper watershed. Cultivated land (wheat, barley, teff, maize, noug) with some stone bunding on slopes of 8-15%. Deep to moderately deep soils. Eucalyptus and hedgerows planted around homesteads only. LCC IIII **<u>Current Problems</u>** Sheetwash on arable land from degraded grazing land upslope. Declining soil fertility and yields **Area:** 49ha **Costing Category:** 2c	**<u>Possible solutions</u>** To retain moisture on arable areas – **grass strips and soil bunds** To improve soil fertility and provide bund stability - **soil fertility management and hedgerow planting** To protect sheetwash onto arable land – **cut-off drains at base of G3 upslope** To prevent further gully erosion – **stone and brushwood check-dams, gully revegetation**
C3 **<u>Description</u>** Arable land (wheat, barley, teff, maize, noug) on steeper slopes (15-30%) in lower watershed. Moderately deep to deep soils with some stones. Stone bunds constructed but need rehabilitation. Eucalyptus and hedgerows planted around homesteads only. LCC IVI **<u>Current Problems</u>** Sheetwash on arable land. Declining soil fertility and yields **Area:** 56ha **Costing Category:** 3c	**<u>Possible solutions</u>** To retain moisture on arable areas and reduce sheetwash – **stone bunds along contour possibly alternating with grass strips in areas of lower slope** To improve soil fertility and provide bund stability - **soil fertility management (compost promotion) and multipurpose tree, shrub and grass planting along bunds**
C4 **<u>Description</u>** Former arable land on steeper slopes (30-60%) in middle watershed, now degraded and used as arable and grazing land. Shallow to deep soils with some stones. Stone bunds constructed but need rehabilitation. No hedgerows. LCC VII **<u>Current Problems</u>** Sheetwash on arable land. Declining soil fertility and yields **Area:** 17ha **Costing Category:** 4c	**<u>Possible solutions</u>** Areas with deep soils and steep slopes (>30%) **will require bench terracing with vetiver strips along the edges and upslope cut-off drain for cultivation.** In areas of shallower soils and steeper slopes – area closure and conversion to forestry

G3 **Description** Former arable land on shallow to moderately steep slopes (8-30%) in upper watershed, now degraded and used as private grazing land. Shallow to moderately deep soils with some stones. Stone bunds constructed previously by GTZ project but destroyed. Some private eucalyptus plantations. No hedgerows. LCC VII **Current Problems** Sheetwash onto arable land below exacerbating gullying in watercourses. Declining soil fertility and yields **Area:** 52ha **Costing Category:** 2g & 3g	**Possible solutions** To improve soil fertility and carrying capacity whilst retaining moisture – **rotating area closure, establishment of grass strips initially with improved pasture between grass strips. Once established grass strips can be converted to hedgerows with fodder crops** Area closure with cut and carry and conversion to forestry and/or silvi-pasture (fodder crops/trees). Community suggest rotation of area closure to retain some land for grazing. To prevent further gully erosion – **stone and brushwood check-dams, gully revegetation**
G4 **Description** Steep (slopes 30-60%) escarpment in upper watershed upslope of G3a. Shallow to moderately deep soils with some stones. No bunding, some eucalyptus planted. LCC VII **Current Problems** Sheetwash onto grazing and then arable land below exacerbating gullying in watercourses. **Area:** 14ha **Costing Category:** 4g	**Possible solutions** To protect sheetwash onto arable land and to channel runoff to suitable channel – **cut-off drains in association with interventions proposed for G3a** Rotating area closure with cut and carry and conversion to forestry and/or silvi-pasture (fodder crops/trees). May need micro-basins to establish trees
G5 **Description** Very steep (>60%) rocky escarpments. LCC VIIId **Current Problems** Few trees **Area:** 3ha **Costing Category:** 5	**Possible solutions** Land closure with establishment of suitable forestry where possible. **Upstream cut-off drain leading to protected watercourse with stone check dams**
F4 **Description** Eucalyptus plantation. Shallow to moderately deep stony soils. LCC IVI **Current Problems** Euclyptus monoculture **Area:**10ha **Costing Category:** 4f	**Possible solutions** Land closure and enrichment planting with indigenous tree species
Community development Investigate possibilities of such interventions as roofwater harvesting, spring development, conservation tillage etc	**Soil fertility management & biological Soil Conservation** **Bund stabilisation using grasses and legumes; contour ploughing and composting, cash crops along bunds; control grazing in bunded areas.**

Enkulal Micro-watershed

Land Development Category	Suitable Interventions
C1 **<u>Description</u>** Large areas of arable land on middle and lower slopes (slopes of 0-8%) in centre of watershed and small areas of arable land on crests. Cultivated land (wheat, barley, noug, maize, teff) with stone bunds but no hedgerows. Deep to moderately deep soils with some stones. Cut by incised watercourses and gullies in places. LCC IId **<u>Current Problems</u>** Sheet wash on arable land. Gullies **Area:** 56.7ha **Costing Category:** 1c	**<u>Possible solutions</u>** To retain moisture on arable areas – **leguminous hedgerows along the top of soil bunds.** To improve soil fertility and provide bund stability - **soil fertility management and hedgerow planting with multipurpose fodder crops and trees** To prevent further gully erosion **– stone and brushwood check-dams, gully revegetation**
C2 **<u>Description</u>** Large areas of arable land on upper, middle and lower slopes (slopes of 8-15%) in upper watershed. Cultivated land (wheat, barley, noug, maize, teff) with stone bunds constructed in past 2-3 years. No hedgerows. Deep to moderately deep soils with some stones. Cut by incised watercourses and gullies in places and bounded by severely eroded land of E3. LCC IIIl **<u>Current Problems</u>** Sheet wash on arable land. Gullies **Area:** 81ha **Costing Category:** 2c	**<u>Possible solutions</u>** To retain moisture on arable areas and reduce sheetwash – **leguminous hedgerows along contour in conjunction with soil bunds** To improve soil fertility and provide bund stability - **soil fertility management (compost promotion) and multipurpose tree, hedgerow and grass planting along bunds** To protect sheetwash onto arable land from E3 and to channel runoff to suitable channel – **cut-off drains** To prevent further gully erosion **– stone and brushwood check-dams, gully revegetation**
C3 **<u>Description</u>** Arable land (wheat, barley, teff, maize, noug) on steeper slopes (15-30%) in upper watershed. Moderately deep to deep soils with some stones. Stone bunds constructed along contour LCC IVl **<u>Current Problems</u>** Sheetwash on arable land. **Area:** 76ha **Costing Category:**3c	**<u>Possible solutions</u>** To retain moisture on arable areas and reduce sheetwash – maintenance of stone bunds **alternate grass strips along contour with stone bunds in areas of lower slope** To improve soil fertility and provide bund stability - **soil fertility management (compost promotion) and multipurpose tree, shrub and grass planting along bunds**

G2 **Description** Private grazing land in upper watershed and area of communal grazing land downslope of severely eroded communal grazing area E3. Shallow stony soils. Slopes 8-15%. No bunds or hedgerows. LCC VId **Current Problems** Sheetwash, overgrazing, lowering carrying capacity **Area:** 21ha **Costing Category;** 2g	**Possible solutions** To improve soil fertility and carrying capacity whilst retaining moisture – **alternate grass strips with improved pasture between. Once established grass strips can be converted to hedgerows with fodder crops.** To stabilise steeply sloping area and to reduce runoff onto severely eroded areas– **conversion to silvi-pasture (fodder crops/trees) and/or forestry. Area closure and establishment of suitable tree crops.** **Note** Rotating area closure may be needed to establish grass strips and improved pasture.
G3 **Description** Area of communal grazing land upslope of severely eroded communal grazing area E3. Shallow stony soils. Slopes 15-30%. No bunds or hedgerows. LCC VId **Current Problems** Sheetwash, overgrazing, lowering carrying capacity **Area:** 20ha **Costing Category:**3g	**Possible solutions** To stabilise steeply sloping area and to reduce runoff onto severely eroded areas– **conversion to silvi-pasture (fodder crops/trees) and/or forestry. Area closure and establishment of suitable tree crops.**
G4 **Description** Area of communal grazing land along road in upper watershed. Shallow stony soils. Slopes 30-60%. No bunds or hedgerows. LCC VId **Current Problems** Sheetwash, overgrazing, lowering carrying capacity **Area:** 2ha **Costing Category:** 4g	**Possible solutions** To stabilise steeply sloping area and to reduce runoff onto severely eroded areas– **conversion to silvi-pasture (fodder crops/trees) and/or forestry. Area closure and establishment of suitable tree crops.**
E2 **Description** Severely eroded lower slopes (8-15%) with active gullies. Moderately deep to deep soils. Area was forested and acacia woodland 30 years ago but converted to arable and grazing land due to erosion. LCC VIIe **Current Problems** Severe sheet and gully erosion **Area:** 36ha **Costing Category:** 2e	**Possible solutions** To prevent further gully erosion – **stone and brushwood check-dams and gully revegetation.** Area closure and conversion to forestry and/or silvi-pasture (fodder crops/trees).

E3 **<u>Description</u>** Very severely eroded communal grazing area with bedrock exposed. Slopes (15-30%) with some active gullies. Shallow to deep soils with rock outcrops in many areas. Area was forested 30 years ago but converted to arable land and then grazing land due to erosion. LCC VIIIe **<u>Current Problems</u>** Severe sheet and gully erosion **Area:** 14ha **Costing Category:** 3e	**<u>Possible solution</u>** To prevent further gully erosion – **stone and brushwood check-dams and gully revegetation.** Area closure and conversion to forestry and/or silvi-pasture (fodder crops/trees). To protect sheetwash onto arable land downslope and to channel runoff to suitable channel – **cut-off drains**
F4. **<u>Description</u>** Areas of natural forest at upper watershed boundary, around church and upstream of spring. Community recognise importance and the forest is guarded and managed by the community. Slopes 15-60% LCC IVl **<u>Current Problems</u>** Livestock encroachment, shortage of funds for guards, shortage of seeds for enrichment planting, shortage of land for nursery. **Area:** 17ha **Costing Category:** 4f	**<u>Possible solutions</u>** Raise funds for guards and for nursery establishment both for forestry enrichment and for rehabilitation of severely eroded areas (see F3a below).
Community development. Investigate possibilities of such interventions as roofwater harvesting, spring development, conservation tillage etc	**Soil Fertility management & biological Soil Conservation including bund stabilisation using grasses and legumes; contour ploughing and composting;cash crops along bunds; control grazing in bunded areas.**

Engule Micro-watershed

Land Development Category	Suitable Interventions
C1 & C2 **<u>Description</u>** Majority of micro-watershed is arable land growing maize, teff, wheat, barley, chickpeas and noug on deep to very deep soils on slopes of 0-15%. Field boundaries often planted with eucalyptus. No bunding. LCC III **<u>Current Problems</u>** Gully erosion in places, flooding of lower slopes, river bank erosion **Area:** 60.8ha **Costing Category:** 1c	**<u>Possible solutions</u>** To retain moisture on arable areas – **leguminous hedgerows at field boundaries, with soil bunds on the steeper slopes** To improve soil fertility and provide bund stability - **soil fertility management and hedgerow planting with multi-purpose fodder, tree and fruit crops.** Investigate potential for small-scale irrigation development **<u>Note</u>** It is unlikely to be economically justifiable to prevent river bank erosion
C3 & C4 **<u>Description</u>** Arable land on moderate to steep slopes (8-60%) with moderately deep stony soils. No bunds or hedgerows. LCC IVd **<u>Current Problems</u>** Sheetwash on arable land. Declining soil fertility and yields **Area:** 134ha **Costing Category:** 3c & 4c	**<u>Possible solutions</u>** To retain moisture on arable areas and reduce sheetwash – **stone bunds along contour possibly alternating with leguminous hedgerows and vetiver hedgerows on the steeper slopes** To improve soil fertility and provide bund stability - **soil fertility management (compost promotion) and multipurpose tree, shrub and grass planting along bunds**
G1 **<u>Description</u>** Communal grazing land on lower slopes in areas of unstable heavy clay soils. Very deep to deep soils. Slopes 0-8%. Very active headward and side slumping gully erosion of E1. LCC IIIe **<u>Current Problems</u>** Severe expansion of E1 gullies into G1. Sheetwash into gullies and surrounding arable land. **Area:** 2ha **Costing Category:** 1g	**<u>Possible solutions</u>** Gully expansion of E1 needs to be treated before improvements can be recommended. To improve soil fertility and carrying capacity whilst retaining moisture – **grass strips initially with improved pasture between grass strips. Once established grass strips can be converted to hedgerows with fodder crops.**
G2 **<u>Description</u>** Crest and upper slopes with shrub vegetation. Shallow stony soils. Slopes 8-15%. LCC VId **<u>Current Problems</u>** Overgrazing and sheet erosion. **Area:** 25ha **Costing Category:** 2g	**<u>Possible solutions</u>** Area closure and conversion to cut and carry feeding or establishment of silvi-pasture (fodder crops/trees) and/or forestry. To protect sheetwash onto arable land downslope and to control runoff – **plant leguminous hedgerows**

G3 **<u>Description</u>** Crest and upper slopes of southern boundary. Shrubland in west and woodland in east. Shallow stony soils. Slopes 15-30%. LCC VIId **<u>Current Problems</u>** Overgrazing and sheet erosion. **Area:** 62ha **Costing Category:** 3g	**<u>Possible solutions</u>** Area closure and conversion to cut and carry feeding or establishment of silvi-pasture (fodder crops/trees) in shrubland area and enhancement forestry in east. To protect sheetwash onto arable land downslope and to control runoff – **rotational closure and plant leguminous hedgerows with upslope cut-off drain**
E2 **<u>Description</u>** Severe active gully erosion in communal grazing land and severely eroded area downslope of wooded hill crest. Soils are very deep to deep but unstable. Gullies initiated by runoff from upslope (G3) and are extending headward and laterally by undercutting and slumping. Slopes 0-15%. LCC VIIIe **<u>Current Problems</u>** Severe gully erosion. **Area:** 8ha **Costing Category:**2e	**<u>Possible solutions</u>** Need to stabilise gullies to prevent further gully erosion – **gully reshaping and revegetation plus brushwood check-dams.** To prevent further gully erosion – **stone and brushwood check-dams and gully revegetation.** Area closure and conversion to forestry and/or silvi-pasture (fodder crops/trees). To channel runoff to suitable channel – **cut-off drains**
F4 **<u>Description</u>** Natural woodland in church compound. LCC IVl **<u>Current Problems</u>** None reported **Area:** 9ha **Costing Category:** 4f	**<u>Possible solutions</u>** Maintain existing closure with enrichment planting with indigenous tree species
Community development. Investigate possibilities of such interventions as roofwater harvesting, spring development, conservation tillage etc	**Soil Fertility management & Biological Soil Conservation** **Bund stabilisation using grasses and legumes; contour ploughing and composting, cash crops along bunds; control grazing in bunded areas.**

5. FORESTRY, AGROFORESTRY AND PASTURES

To understand the physical and biological reasons of degraded watersheds of the Abbay River we must go back to the situation when natural forests clothed its upper catchments. Simply stated, these forests broke the fall of heavy rain. This minimized the rate and amount of water leaving the landscape. Rather, it fell gently to the ground which was covered in a layer of dead organic matter. Some water ran off but most percolated through the soil to re-charge groundwater and eventually to enter streams of pure water further down the catchment. Under this natural system, the soil remained in place and the rate of leaching of nutrients was minimized. Nutrients which were leached to deeper layers of the soil were later recovered by the deep roots of trees and returned to the topsoil through falling leaves. Nitrogen from the air was added to the soil through the symbiotic relationship between bacteria housed in the roots of leguminous trees, shrubs and herbs. This is known as a closed system which renews itself unless disturbed by geological activity.

When the system is opened by human activity as described below, there is a rapid increase in the rate and amount of water leaving the landscape, especially from steep slopes and when it is concentrated in road drains. Soil, loosened by ploughing and other agents, is taken with it to fill streams and rivers with sediment. Leaching of nutrients is enhanced because the soil surface is no longer protected, even on grazing land, and there are few trees left to recover the nutrients lost from the topsoil. Moreover, too many grazing ruminant animals remove the best grasses and shrubs as well as herbaceous legumes. Thus the nitrogen and carbon cycles, which maintain soil fertility, are broken and the land spirals downward to an equilibrium of poverty for the people who inhabit it.

Now there is a big gap between local crop yields and what agronomists say is possible under the climatic conditions prevailing in the highlands. The reasons for this are believed to be:

- **traditional farming practices**, particularly multiple cultivations up and down a slope for seed-bed preparation;
- **a decline in soil fertility** due to soil erosion and leaching of nutrients by heavy rain;
- **a continuous expansion of crop land** to steep slopes and to grazing areas along river valley bottoms which have been degraded already by too high numbers of livestock; and
- **the destruction of forests** to meet the demand for construction timbers and fuel wood.

When the above reasons for low agricultural productivity are coupled with inadequate and/or inappropriate soil and water conservation practices, the result is high sediment loads in rivers and streams. The Project offers a unique opportunity to measure the effect of its activities in the fields on the slopes above the streams on the quantity and quality of water entering them. Thus, one of the first tasks of the project is to put gauging stations in place on water entry points to the streams which flow through the development clusters of micro-watersheds. In this regard, the headwaters of the Enkulal River are special in that a comparison can be made with sediment loads coming from a pristine natural forest on one “head” of the micro-watershed and sediment loads coming from a cleared, ploughed and cropped slope on the next “head”. Moreover, there is a historical reference point. The senior forest guard has lived in the micro-watershed all his life. He claims that the degradation has occurred mostly in the last 25 years as people moved in to clear most of the forest land for farming.

Is it possible to reverse the downward spiral mentioned above? The answer is “Yes” but to apply the remedy is quite difficult because it must accommodate the livelihoods of those who live in the watersheds. It also takes time. What must be done is mimic the natural system from the beginning by finding ways to hold the water in the landscape for longer periods of time. The first steps are to break the fall of the rain, increase the amount of water entering the soil where it falls, slow its percolation rate, and harvest the water which runs off. These three steps must be taken simultaneously and in a timely manner by land users and managers. They must be willing to **establish <u>and</u> maintain** this foundation for the future of agricultural productivity and land reclamation. Taking the first step will be the most difficult. It will require the persuasion of people to plough the land on the contour to encourage percolation at the same time as reclaiming the slopes above the "keyline"[5] for permanent crops of trees and pastures. This process will interfere with the present fragmented patterns of land holding and use.

5.1 The first step

Since forestry and agro-forestry developments ranked very low in a list of eight (8) priority sectors in each micro-watershed during community consultations, there will need to be a dialogue with farmers before entering into any field activity. At the outset, the rules and regulations by which communities manage natural forest remnants for different purposes, including bio-diversity, non-timber forest products and selective harvesting, will need to be established. Once farmers have confidence in the planting which needs to be done and where, then the establishment of tree nurseries[6] needs to be started as early as possible. This is estimated to be in the second wet season after the commencement of the project unless it begins at the start of a dry season (November). If that is the case, there is a possibility of being ready for nursery establishment in the first wet season thereafter (June-October). The next important steps are to get community agreement on areas for temporary closure, including staggered closure and areas for planting, and to establish their interest in providing paid labour to establish, manage and maintain forest plantations as a community asset.

Once the community is convinced of the priority of starting early to prepare for reforestation and commercial agro-forestry, the process of nursery establishment, closures, planting, management and maintenance should be in full swing by the third year and continue thereafter to the fifth year.

5.2 Forestry

Natural forests in ANRS are classified, administered and managed by BoARD at the regional level and OARD at wereda level. These are classified as:

- Priority State Forests (PSF);
- Regular Forests;
- Community Forests.

According to Forest Administration Law, PSFs are owned and administered by the regional states for the purpose of genetic resource conservation and environmental protection. Regular natural forests are smaller in size than PSFs. These are administered and managed by the wereda OARDs. The future plan for PSF and wereda forests is to have them administered and managed participatively by joint committees of government and community representatives.

Community forests are the property of communities and administered and managed by them. Guards are appointed from among a community to take care of them. For their services they are allowed to collect dry wood and branches and to cut-and-carry grasses for their animals or to sell. If a community sells timber from these forests, it pays a royalty to the regional government. Some communities actively manage their forests by enrichment planting and enclosures. In some forests, controlled grazing and browsing is allowed.

Reforestation and afforestation with natural forest species (see **3.3** above) will be part of the project's soil and water management activities (see **4.** above) to reclaim the badlands and to stabilize gullies and water courses.

[5] The keyline is the line in a watershed where the slope changes abruptly.

[6] An alternative, of course, is to purchase tree seedlings from existing nurseries if they have the stock needed and are easily accessible.

5.3 Agro-forestry

Agro-forestry is known by foresters alternatively as "farm forestry". It comprises scattered trees planted deliberately in crop fields or along crop field boundaries, trees planted on non-arable land around homesteads or in gullies for gully stabilization, and multi- story woodlots planted by private farmers. The agroforestry packages classified by BoARD are:

- Homesteads agro forestry;
- Multistory farming which includes forest trees and fruit crops;
- Trees occurring on farm land (both natural and man made);
- Alley cropping (hedgerow and intercropping);
- Boundary tree planting;
- Road side plantation;
- Trees planted on grazing land;
- Living fences;
- Wind or shelterbelts; and
- Trees planted on gullies for gully stabilization.

In some quarters, agro-forestry also applies to the planting of fruit trees either singly, in home gardens or in orchards. In other quarters, these activities are known as horticulture. Whatever the case, the production of fruit is important for family nutrition and could be a profitable alternative to annual cropping of steep slopes. The potential in the varying agro-climates of the project areas is considerable.

For further information on forestry and agro-forestry see Halcrow, 2007a.

5.4 Permanent Pastures

Permanent pastures are treated here with forestry and agro-forestry because they fit together in their contribution to soil and water management and the need to move towards permanent agriculture on steeply sloping land. However, the idea of introducing new plants and managing them as a "crop" is not known in the project areas. Farmers know the value of indigenous *Trifolium* spp. but are unaware of how to mange these excellent plants with others to provide feed throughout the year. Therefore the Project will need to engage in the classic process of extension which is to: *get attention, develop interest, build confidence, create desire, ensure action* and *maintain satisfaction*. This will require demonstrations of pasture species and their management, in the context of a given farming system, to create a Feed Year from permanent pastures and browse shrubs on the high slopes, to impermanent pastures leys on the low slopes and fodder crops such as oats and vetch as a break crop wherever needed. For this purpose international technical assistance will be essential, especially for the establishment and management of mixed grass-legume pastures which are the best of all permanent pasture systems.

5.4.1 Improved pasture demonstrations

By definition, a demonstration brings to a client's notice something which has been tested and shown to work. But the process of assimilating and accommodating new technology in agriculture must be addressed if one expects to achieve its uptake by farmers. Therefore, the demonstrations proposed for pasture improvement are in two stages.

Stage 1. Introduction Gardens

In extension language, this stage is *"to get attention, develop interest and build confidence"* in project areas where there has been no previous activity concerned with the development of improved pastures. Fenced plots of about 400 m^2 will be established. The area enclosed will be cultivated. Grass and legume species, assessed as suitable for the area, will be planted in rows up to 10 m long and 1.5-2.0 metres apart. With advice, the farmer cooperator can harvest the rows for hand feeding his cattle or other animals.

After two years, if the demonstration has introduced successfully the possibility of new and better plants for feeding animals, it can be used for seed production and vegetative planting material. It can continue for as long as the cooperator wants to maintain it. If this step is completed already in a project area, or on an individual farm, extension officers should go immediately to Stage 2. Grazing Areas.

Stage 2. Grazing Areas

This stage is to *"create desire, ensure action and maintain satisfaction"* by demonstrating the value of grazing improved pasture and the different strategies which might be used to make the best use of it. The minimum area to be developed should be 0.5 ha. Supervision should go on for at least three growing seasons. By that time farmers will be satisfied with the idea of an improved pasture or they will have discarded it. If the farmers are satisfied, extension officers must not just disappear, never to return. They need to make regular visits to assist with problem-solving in the area expansion stage when farmers have to make all the decisions themselves and find all the inputs they need.

Site selection

This is a most important step. A Pasture Development Team (PDT) should be fully familiar with the soils, vegetation, topography and climate of the project area into which they propose to introduce new plants for a specific purpose. And they should be clear about the clients whom they are trying to reach with an Introduction Garden or a Grazing Area. The process of site selection should begin well before the time to establish a demonstration. Some time should be spent visiting villages and holding discussions with farmers before settling on where and with whom a demonstration should be conducted. Moreover, there could be more than one demonstration in a village to indicate variability in human capacity to take up the idea, and what information may have been missing in the case of failures[7].

The first visits should be made early in the dry season before farmers are busy preparing their land for staple crops. The final choice can be made after this period but before sowing begins.

It is important to make a detailed description of the sites and to take soil samples for chemical analysis. An essential detail is site history. If the site is located on virgin soil or on soil which has been under bush fallow for a long time, plant growth in the first and second years of a demonstration is likely to be good; this can give a false impression of what the future will hold when soil nitrogen runs out and grass yields decline. Alternatively, if, for convenience, a farmer wants to put his plot on old cultivation land or degraded land where natural fertility has been used up, a poor result can be expected unless the correct fertilizer is used at establishment and for maintenance.

The PDT should look further ahead as well and try to locate sites where they are easily visible by people passing by or from a distance. This criterion, however, should not compromise site selection in terms of biology.

Species selection

The PDT needs to evaluate, carefully, existing information on grass and legume cultivars as well as any field experience with them in Ethiopia, e.g. Andessa, ILRI. Up to five grasses and legumes should be selected relative to the purpose of the demonstration, e.g. forage or fodder, climatic and edaphic adaptability, early vigour and future persistence, and tolerance

[7] Failure must be accepted in the sense that this is how we learn. In one case study in one village, nine Introduction Gardens were established: five established well, two were moderately successful and two failed completely. The community were undaunted by the failures which were explainable. They were keen to go on to establish 300 ha of controlled communal grazing land in the mountains.

to grazing. It is better to have a good range of species and not to fear that some will fail. A great deal can be learned from failure. Moreover, there are numerous stories of advisers returning to Introduction Gardens years after they have been abandoned, to find that a species which was not considered useful, has taken over the site.

Establishment

The timing of establishment will depend on the purpose of the demonstration and the method of establishment. Introduction Gardens can be established at any time in the wet season, the earlier the better. Grazing areas will be different depending on whether the pasture species are under-sown with a staple crop or are sown directly into lightly cultivate land. In the former situation, decisions may be taken to sow the seed at the same time as the crop or after the final weeding. Sowing directly into rough cultivation must be timed prior to the onset of a storm so that the rain will cause the seed to be covered with soil and compacted.

Farmers need to be advised specifically about depth of sowing and soil compression around the seed. Failure to recognize the different sowing needs of large-seeded cereals and often minute-seeded pasture species is a common cause of disappointment in the early years of pasture development. This assumes, of course, that the viability and purity of the seed used meets standard quality guide lines.

Maintenance

Several things are important to remember. First, pasture improvement in the project areas represents the beginning of the deliberate and controlled use of plants and animals to achieve a particular purpose. It is essential that the Introduction Gardens and the Grazing Areas are fenced securely to either exclude or enclose, at different times, the animals for which the pasture was established. However, once cattle are enclosed consideration must be given to their water requirements and how they will be satisfied relative to season, e.g. in the wet season cattle can go to water every two days without detriment but in the hot, dry season they must be watered daily if their performance is not to suffer. In this activity, the children who herd the cattle can be engaged in the process if physical fencing is not available. They know a great deal about animal behaviour and will follow instructions well if explanations are given why certain things must be done at certain times.

Second, if an Introduction Garden is used for cut-and-carry for several years, then potash reserves will be depleted as well as soil nitrogen.

Third, in Grazing Areas where grasses and legumes have been planted together at the same time, and if soil nitrogen levels are high, extension staff should expect the vigorous, tall-growing grasses to shade the slower-establishing legumes and thus suppress their growth. Therefore, early grazing is essential to remove the grass canopy to allow light into the legumes. The periods of access should be only long enough to achieve this, otherwise the legume seedlings can be damaged by trampling.

Utilization

There are different ways of using small areas of improved pasture to maximize the benefits provided by improved quality and quantity of feed per unit area. Cattle can be enclosed close to home during the growing season when staple and other crops are vulnerable to damage. When the crops are harvested, the cattle can be set free to forage over a much larger area in the dry season. The pastures can be used to flush breeding cows after the first rains or they can be used exclusively to finish sale stock over three months during the growing season. Such strategies need to be discussed with a farmer according to his purposes and needs as the demonstration moves through time.

Recording

In addition to a detailed description of a site, it is essential to record what was done at establishment, when it was done, and how it was done. A rain gauge should be set up at the site and the farmer shown how to read it (and what to do during prolonged period of heavy rain). Qualitative records of temperature should be kept during the cool season in highland areas, particularly if frost could occur. Farmers can record periods of extremes like very cold or unusually cold for a week, or three frosts in a row.

Simple yield estimates from an Introduction Garden are useful e.g. number of bundles (of known standard size) cut per row, and when cutting occurred. For grazed areas it is essential to record when cattle are put on pasture, how many and for how long (keep the date of when they are taken off). If stock numbers are reduced partially, the number of animals taken off (or remaining) must be noted. These records allow calculation of the number of cattle grazing days to which the pasture has been subjected, and during what period.

Finally, all discussions with cooperators (and other interested persons) should be recorded. Questions raised need to be followed up with answers or explanations as soon as possible. If there are no answers immediately available, the matters raised should be referred to a research centre as a possible research topic.

For further information of pasture development see **6.2.2 Feed supply** below.

6. FARMING SYSTEMS

Farmers in the three project areas mostly practice a cereal-based, mixed farming system under rainfed conditions which involves crops, livestock and agro-forestry. There are two types, a mixed cropping system and a crop-based system with livestock. Both may or may not have small eucalyptus plantations or other trees planted for specific purposes.

There is only one cropping season, the *meher* or rainy season. The crop production sub-system is almost entirely at subsistence level in the low-input, low-output category. Most of the population grow and consume their own food. Within this farming system, cattle are kept throughout the year on natural pasture as a source of draft power and as an asset for sale in case of emergency. Complementing this dual purpose, are sheep and goats for meat and some milk, and equines (horses, donkeys) for human transport or pack animals.

The average land holding of each household is less than one hectare. “Farms” are often fragmented. However, a closer look suggests that fragmentation is deliberate to allow families access to different land types for different purposes, e.g. bottom lands for grazing, gentle slopes for crops, steeper slopes for terracing or forestry and grazing.

Some small-scale, pump irrigation is practised using flat land near to a permanent water source e.g., in Engule micro-watershed, Jema watershed, about 50 ha of land is irrigated to produce vegetables, fruit and coffee. Some homesteads have gardens to produce vegetables and fruit under rainfed or irrigated conditions.

Cultivation of the land is carried out by the traditional, ox-drawn plough or *maresha*, with several passes to produce a seedbed according to seed size, e.g., for teff there could be one or two more passes (Table 9). Weeding of crops is usually done by hand and could be up to three times (Table 9). This is the first farm operation to suffer when there is insufficient family labour due to ill-health or other problems. Harvesting is done by hand. Threshing is accomplished by hand or by oxen treading the harvested material.

Sources of income are surplus cereals, cash crops, livestock, non-timber forest products wage labour, and non-farm sidelines. Net income varies around ETB 2,000

6.1 Crop production sub-system

The major crops grown are cereals (teff, wheat, barley, finger millet and maize), pulses (chick peas, lentils, field peas, faba bean, horse bean) and oil seeds (noug and rapeseed). Tuber crops like potatoes, are becoming important as a cash crop.

In the mixed farming system, different combinations of crops are cultivated based on the onset of rainfall and duration of crops in the field until harvest. Therefore, a cropping calendar and cropping pattern may vary according to site and season. As an example, an indicative cropping calendar for Mecha wereda in Jema watershed is presented in Table 9. There is a peak labour requirement from March to August when cultivation, planting, and weeding operations overlap for some of the crops. This example is extended to include an incomplete input/output picture for crop production in Mecha in Table 10.

Fertilizing crops is a normal practice but the amount applied is usually less than that recommended. The blanket recommendations for the use of only two fertilizers, DAP and urea, are indicated in Table 10. Moreover, urea is usually broadcast which means that only about 50% of its nitrogen content (46%) will be recovered because of volatilization. The resulting yield response would be much less than expected. This could be one reason why farmers complain that fertilizer prices are too high. Understanding fertilizers and fertilizer use must be an essential part of any DA or farmer training programme. It is also time for the extension approach to move beyond the Training and Visit system to an advisory approach in which both farmer and adviser participate in discussion as equal partners and problem solvers.

Other complaints of farmers include the availability and high price of pesticides and the availability of improved seeds at the right time in the right place. Pest problems include wheat rust, aphids, boll worm, shoot fly, stalk borer, weevils and rodents. The BoARD advise that the appropriate departments are moving with the private sector to solve these issues.

Table 9. Cropping calendar for the major crops in Mecha wereda, Jema watershed

Crop	Ploughing (Frequency)	Sowing	Weeding (Frequency)	Harvesting
Maize	March-May (3-4)	May	July-Oct (2)	December
Finger millet	March-May (3-4)	June-July	Aug-Sep (2-3)	January
Barley	March-May (3-4)	June-July	Aug-Sep (2-3)	Sep-Oct
Wheat	March-May (3-4)	June-July	Aug-Sep (2-3)	Sep-Oct
Teff	March-May (4-5)	June-July	Aug-Sep (2-3)	Dec- Jan
Horse bean	May	June	July-August	November
Field peas	May	June	July-August	November
Noug	May	June	July-August	November

The estimated yields shown in Table 10 reflect the situation in the Farta, Dera and Este weredas in the Ribb and Gumera watersheds. This suggests that there are significant opportunities to improve crop productivity such that the livelihoods of farmers within the watersheds could be improved in a relatively short period of time, all other things being equal. However, it is clear that good crop husbandry may be constrained by labour availability during critical periods like sowing, weeding and harvesting. Moreover, some farmers, especially from female-headed households said there was a shortage of oxen to own or hire for timely land preparation.

This has led to the working hypothesis that "an improvement in specific social services which improve human health and which save time will lead to more energetic and effective labour with more time to carry out essential farming operations". Similarly, the problem of shortage of oxen will be solved if a "stop the animal losses" programme is implemented led by a basic animal health service which is easily accessed by farmers with sick animals (curative service) and which delivers an effective, disease prevention service.

6.1.2 Proposed interventions

Discussions with farmers suggested that they have a good understanding of their land in the context of traditional farming practices. Some indicated they would be happy to get involved with on-farm demonstrations of improved practices, high-yielding crop varieties and new crops *provided* they had the time and the land to commit. It was also evident that BoARD staff at all levels had the knowledge of crops to impart but they needed practical experience to adapt to the idea of participation in the whole process of deciding what to do and how to do it, rather than telling farmers what to do and then leaving. Furthermore, they needed a budget and transport to deliver this approach in the form of on-farm demonstrations with support from Adet Agricultural Research Station which is the responsibility of ARARI.

With these perceptions in mind the following interventions have been costed in the project:

- Demonstrations of improved cropping practices and systems. Important techniques to be demonstrated which communities could choose to include in their CAPS are: appropriate fertilizer use; integrated pest management; contour ploughing; and stabilization of terraces and gullies with useful trees and shrubs, perennial pasture grasses and legumes or good stabilizers like Vetiver grass, which are less palatable

Table 10. An incomplete input/output picture for crop production in Mecha wereda, Jema watershed

Crop	Area cultivated	Seeding rate	Fertilizer rate	Estimated yield	Price	Income from grain	Gross income	Input cost	Net income
Cereals	**ha**	**Kg/ha**	**Kg/ha**	**t/ha**	**ETB/t**	**ETB/ha**	**ETB/ha**	**ETB/ha**	**ETB/ha**
Maize	22,810	25	DAP 200 Urea 150	4.3	1,200	5,160	6,160[8]	2,000	4,160
Finger millet	15,425	50-60	DAP 100 Urea 50	2.0	1,600	3,200	3,900	1,030	2,870
Teff	10,050	40	DAP 100 Urea 50	1.1	3,900	4,290	5,490	1,140	4,350
Barley	2,105	150		1.8	2,500	4.500	5,400	675	4,725
Wheat	1,675	150		2.0	2,800	5,600	6,500	720	5,780
Pulses									
Grass pea	1,445	n/a		1.3					
Horse bean	1,345	270		1.0					
Chick peas	1,150	n/a		1.0					
Field peas	1,080	150		0.9					
Oil seeds									
Noug	10,310	15		0.5					
Tubers									
Potato				6.0					

[8] A value of ETB900/ha is included for maize stover, and ETB 700, 1,200, 900 and 900/ha for straw from finger millet, teff, barley and wheat respectively.

to animals. Important variations within cropping systems to stabilize and even improve productivity are alley cropping; intercropping; cover cropping in tree plantations or orchards; strip cropping; and pasture leys. At system level, there are opportunities to demonstrate more efficient variants of small-scale irrigation systems;

- Demonstrations of high-yielding crop varieties and new crops. Possible high value crops to be demonstrated are: new (and old) varieties of potato; malt barley; vegetables; multi-purpose bamboo; and perennial tree crops such as avocado and citrus according to the agro-climate of the area along with market promotion of the produce once the crop is established and accepted.

Any enthusiasm to take up what these demonstrations offer will be blunted if the project does not look also at working with the BoARD (Agronomy Section), OARDs, DAs and the private sector to:

- Improve the availability and timely supply of inputs;
- Stop losses in storage and delivery of produce to market; and
- Facilitate the delivery of materials, equipment and knowledge.

Funds have been allocated in the project to respond to these needs.

For detailed information on crop production in the three watersheds see Halcrow, 2007b.

6.2 Livestock production sub-system

Many farmers operate farming systems with a mix of crops and livestock. The primary purpose of a cattle sub-system is to provide oxen for ploughing. During focus group discussion with communities “shortage of oxen for ploughing” was a common theme raised. The shortage translates into “a high price” if a farmer wants to buy a pair of oxen and the cost of hiring a pair becomes significant in the total cost of crop production. Moreover, in the latter case, availability can have an effect on the good timing of land preparation. This problem particularly affects low-income families and female-headed households. Otherwise, cattle and small ruminants like sheep and goats provide financial security for families, particularly when lumps of money are required to meet health, educational and social commitments. Moreover, they can be sold according to need.

At a lower level in the hierarchy of livestock production systems, chicken raising is of equal utility even though individual value is small. A small chicken-raising operation is often the first step on the ladder for low-income families to have enough money to buy sheep and goats, and ultimately to have their own cattle. There are several other opportunities for increasing the importance and value of livestock in a mixed farming system. These are milk production and processing, short-term (about 3 months) fattening of steers for local and international markets by stall-feeding or grazing on quality improved pastures, the intensive fattening of sheep and goats especially timed for festive periods during the year, and improved methods of bee-keeping.

For security reasons, grazing and scavenging livestock, like chickens, are confined at night under or near an owner's house. One consequence of this is that, once in every 24 hours, there are large numbers of livestock concentrated in the small area of each village. This provides ideal conditions for the transmission of disease organisms and parasites. Thus herd and flock productivity are low due to losses by death and morbidity e.g. an outbreak of pasteurellosis could cost a village up to 15% of its adult cattle while deaths in young chickens from Newcastle disease can be as high as 90%. Under these circumstances more animals must be kept for herd and flock replacement. This puts additional pressure on the natural feed resource which is limited in quantity and quality, and in its distribution throughout the cycle of the seasons.

6.2.1 Proposed interventions

If farmers are to improve the rate of output of work, food or money from livestock production systems, it will be imperative "to stop the losses" in village livestock. Only then will it be worthwhile to pay attention "to making gains" in productivity through improved systems of feeding and management. This is the rationale behind the principal intervention proposed for the livestock component under the theme of Sustainable Livelihoods.

Animal health. The primary problem farmers face in livestock production is that the loss of just one animal in a small population is a significant loss of capital. We can stop the losses or reduce them to a minimum because the knowledge and experience is available. What we must do in the project is to make this available and physically accessible to livestock farmers. Therefore, the primary purpose of the Livestock Component is to address this dilemma by up-grading existing animal health posts and establishing new ones to improve the access of livestock owners to an effective, basic animal health service (BAHS) which can reduce morbidity and losses. This programme will start villages within the nucleus micro-watersheds or near thereto. In the expansion phases of the project, these posts will be planned to fit the new programme of the BoARD (Animal Health Section) to have a post for every three kebeles and within three kilometers walking distance for livestock owners. The present situation is one post in every 7 kebeles and within 7 km walking distance.

This strategy is based on the fact that most of the serious diseases that affect cattle, sheep, goats and poultry can be prevented easily by vaccination, in the case of infectious disease, and by simple preventive and curative treatments like spraying and drenching, in the case of parasites.

To provide successful technical support to this strategy, the BoARD (Animal Health Section) must be able to investigate problems in animal health in conjunction with the Regional Veterinary Diagnostic and Investigation Laboratory (RVDIL) in Bahir Dar. Simple studies such as parasitological surveys are essential. Complex studies will require samples, e.g. blood, to be taken from village animals and transported to the RVDIL or to the National Laboratory in Addis Ababa.

Feed supply. Interacting with animal health as a problem is the shortage of feed relative to the number of animals owned. Indeed, some farmers identified “shortage of feed” as equally important as “shortage of oxen”. Moreover, the practice of free grazing with high numbers of animals leads to very high grazing pressure of existing pastures. The resulting poor ground cover enhances the potential for erosion. As well, without enclosures or other controls animals can cause the destruction of bunds and terraces which are meant to control erosion.

The knowledge and techniques to improve feed availability throughout any year and thus animal productivity from the same area of land with the same or lower number of animals is available. However, there is a big gap between local knowledge and experience of perennial pasture development and what is known and has been achieved internationally. Therefore, this sub-component will be implemented with a mixture of research, extension and on-farm demonstration, always with farmers as cooperating partners. Experienced international technical assistance will certainly be required to enhance the research and development process beyond the minimum starting point of measuring dry matter yields of local and introduced species of grasses and legumes at the Livestock Research Centre at Andessa.

The purpose of the feed supply sub-component is to develop a pasture and forage feed year using annual and perennial species, either local and/or introduced. It will start with the knowledge that Ethiopia is a centre of origin for top quality perennial pasture species: these are kikuyu grass (*Pennisetum clandestinum*) and African *Trifolium* species such as *T. ruepellianum*, *T. quantinianum* and *T. semipilosum.* These can be used as managed pastures or in soil and water conservation measures. Farmers and children who herd the livestock in the project areas already know the value of the *Trifolium* spp. They are also aware of the problem of bloat when the plants are young and growing rapidly after the first rains. What the project can do is to introduce them to ways and means of managing these species for grazing and fodder conservation to contribute to a Pasture Feed Year. Another aspect of these *Trifolium* spp. is that, in protected areas, e.g. on the tops and slopes of hills where ancient churches stand, they are able to flower and seed profusely. The flowers are worked by bees for honey and the seed maintains the species in the landscape.

These *Trifolium* species also grow naturally with kikuyu. Unfortunately, this excellent grass has virtually disappeared from pastures due to selective grazing: younger farmers (<40 years of age) probably would not be aware of it or its potential. Lush stands of the grass are used as decorative features on the central reservation along main roads in Bahir Dar.

5.3 Variability in Farming Systems

The variability in agro-climatic conditions (Tables 5, 6, 7 and 8) throughout the project areas has led to some variability in farming systems but this situation could be exploited further. Variability in altitude within the agro-climatic range from weyna dega to wurch provides opportunities for some areas to specialize in different cereal varieties and different fruit, vegetable and pasture species.

For example, the development cluster of micro-watersheds around Kantai lies in the higher range of the moist to wet dega agro-climatic zone. Kantai itself (near Gasay meteorological station) is about 2,800 m (a.m.s.l) with an average (n=8) rainfall of about 1,370 mm and average (n=5) max/min temperatures of 21/6 ^{0}C. The growing season is from 150 to 180 days. This makes it ideal for the establishment of temperate crop and livestock farming systems with associated temperate cereal varieties and perennial pasture and tree crops. Small-scale milk production is undertaken already. The milk is processed at Gasay. The climate is suitable for temperate fruits like apple, pears and plums and the scope to expand potato production is considerable. But this potential will be unrealized unless a feeder road is constructed out of the development cluster to connect with the main road from Debre Tabor. Therefore, the project will construct an 11 km feeder road along a ridge between the nucleus micro-watershed and a contiguous micro-watershed to facilitate market access for the output from these new crops.

In contrast, the development cluster of micro-watersheds around Enkulal (about 2,400 m (a.m.s.l) lies in the warmer, dry, weyna dega agro-climatic zone. The nearest meteorological station to Enkulal is at Arb Gebeya the altitude of which is about 600-700 m lower at about 1,800 m a.m.s.l. Its average (n=7) rainfall is only about 850 mm and average, synthesized max/min temperatures are 29/12 ^{0}C. The growing season is only 90 days. This makes the agricultural environment more suitable for farming systems of the cool, dry sub-tropics where maize is a main crop. Even so, annual cropping is much more risky than in Kantai and drought tolerant species like sorghum may replace barley as a cereal crop in some areas. A move towards animal agriculture would be more appropriate here with a wider use of perennial tropical pastures and shrubs, e.g. Stylosanthes spp., Neonotonia wightii, and possibly tropical tree crops like papaya and mango.

7. AGRICULTURAL SUPPORT SERVICES

To facilitate the implementation of an integrated watershed development project, it is crucial that capable agricultural support services exist at regional, wereda and kebele level to provide essential technical and material support to local communities. Moreover, It would be impossible for project implementers to provide all the services needed as a result of the preparation of Participatory Land Use Plans (PLUPs) and Community Action Plans (CAPs).

An exhaustive study of institutions and organizations in Amhara National Regional State (ANRS) began at the outset of the project preparation in January and February 2007 and continued throughout the year until the middle of October. This chapter summarizes the results of this study and gives the background to the Consultant's recommendations.

One outcome of this detailed investigation is that there appears to be a serious discontinuity between the number of institutions and organizations serving the rural areas of the Region and their under-developed social state and degraded physical state. Clearly, the project must address the reasons for this discrepancy wherever possible.

7.1 Agricultural research

7.1.1 Adet Agricultural Research Centre

There is a good agricultural research facility at the Adet Agricultural Research Centre approximately 40 km south from Bahir Dar. The research station was funded originally by the European Union 20 years ago. In recent years it has been suffering from under-resourcing for outreach activities and budget problems. Nevertheless, the station is expected to provide technical advice to no less than 40 Weredas! These include the weredas in which the project areas are located. The project could engage this facility in on-farm research and demonstration work with a vehicle and an operating and maintenance budget for tools, equipment and a computer. Two approaches are followed: a programme approach by subject and team approaches for watershed development.

The Centre provides services in the Debre Tabor and South Gondor areas on potatoes, wheat, faba beans, linseed and sporadic pest outbreaks. The main research crops appear to be maize, oats, vetch, early varieties of linseed, seed potatoes, bread wheat, and rice for the Fogera plain area. The pasture research unit was transferred to the Livestock Research Centre at Andessa in 2007 but adapted tropical legume introductions like *Desmodium intortum* and *Desmodium uncinatum* are still growing well in uncultivated areas of the Station and along roadsides. The red-flowered, ball-headed *Trifolium quantinianum* was also present in dense swards in the same areas where tall grass competition was not strong.

There are 11 research projects in agroforestry. These include alley cropping, the potential for highland bamboo and documenting wild edible and medicinal plants. There is also a horticulture section which works on fruit tree crops such as apple, mango and papaya.

The extension research unit has tried to establish farmer research groups, but this is proving to be difficult. It lacks the capacity to follow up contacts away from the Centre.

The main constraints facing the research station are: lack of vehicles which limits activities due to the long distances; a lack of field professionals; and difficulties in the scaling up of seed production. Farmers are reported as not always able to use the new seeds and approaches due to the high cost of fertiliser. In addition, the prevalence of grain aid is causing uptake problems of improved varieties: farmers tend to be interested but not committed to adopting new ideas when grain is provided free. These dilemmas resonate in the view of the Director-General of the Amhara Regional Agricultural Research Institute (ARARI) which is responsible for Adet. He argues that there is a problem of commitment at various levels to extend and /or adapt new and improved technologies. A starting point would be the allocation of sufficient budgets to weredas and kebeles. The D-G also stated that new/improved technologies are adopted faster for crops with good marketing opportunities. Therefore, marketing of crops must be given due attention by the project.

7.1.2 Andessa Livestock Research Centre

The Andessa Livestock Research Centre is about 30 minutes drive south-east from Bahir Dar. It has active programmes and a young staff who are committed to making strong links with the surrounding farming communities. As usual, the Centre is under-resourced in terms of transport and an operating and maintenance budget.

There is a major project on the preservation, and improvement by selection for milk production, of the local Fogera cattle breed. It is hope that this will make a significant contribution to the continued establishment and strengthening of a dairy industry in the Region.

The pasture research team is active in the measurement of dry matter yields of promising legumes and grasses in replicated plots after the initial introduction and observation of exotic species at Adet. Whereas there is much to be done to improve the management of this activity, this has not deterred the staff in both projects from taking the leap to on-farm research and development through Farmer Research and Extension Groups. They are supported by a socio-economic group based at the Centre.

Dairy heifers of the Fogera breed or cross-breeds were supplied to interested farmers who have established plots of improved pastures for cut-and-carry for midday and evening feeding at the homestead. These heifers are now lactating cows producing at peak 10 L/day. Half goes to a calf and half is carried to the local processing plant. As one female farmer said “the income from my cow pays for my children’s education”.

Grass species used by the farmers include: *Pennisetum purpureum* (Napier or elephant grass), *Panicum coloratum* and *Chloris gayana* (Rhodes grass). Some legumes being investigated on-station are: *Desmodium intortum, Neonotonia wightii, Stylosanthes guianensis* and *Trifolium quantinianum.*

In addition to milk production, the station has programmes on *Bos indicus* bull production to improve the fattening potential of local breeds, developing the Washera sheep breed, poultry production systems and bee-keeping.

7.2 Agricultural extension

During the initial field work, a number of DA’s assisted the Consultant, including two females. They were found to be quite well trained, active and supportive towards the communities, but they lacked the resources to achieve much in the field. During the year, the Consultant worked extensively with many DAs in the field to carry out the socio-economic baseline studies, to establish values for technical parameters in production systems, and in the preparation of PLUPs and CAPs. They proved to be cooperative and helpful. This work provided a comprehensive understanding of the strengths and weaknesses of the agricultural systems now operating in the project areas.

It was clear that the capacity of the DAs and health staff at kebele level needed to be enhanced by providing:

- Means of transport: bicycles/motorbike;
- Basic office equipment;
- Tools and equipment required for conducting field activities and demonstrations;
- Furniture and equipment for Farmer Training Centres;
- Land for establishing demonstration plots;
- Budget and equipment (e.g. water pump) for conducting demonstrations;

- Training curricula and materials; and
- Regular training courses to refresh and enhance skills and knowledge.

Wereda offices of agricultural and rural development (OARDs) provide subject matter specialists who support DAs. Those visited initially in January and February appeared to be functioning and reasonably well equipped. However, this assumption was unfounded. A detailed investigation in June and July showed that the major constraints for most, if not all, the OARDs visited are as follows:

- Insufficient means of transport (i.e. cars and motorbikes);
- Insufficient budget for O&M of available cars and motorbikes;
- Insufficient computers and other office facilities;
- Insufficient budget for training of Wereda staff and DAs;
- Inability to recruit experienced staff with necessary skills and knowledge due to relatively low salaries and poor working conditions;
- Rapid turnover of staff due to living conditions in more remote weredas;
- Shortage of staff due to vacancies;
- Inaccessibility of substantial number of kebeles due to lack of access roads; and
- Lack of (appropriate) training curricula and materials for farmers' training.

In addition to more means of transport and budgets, all the OARDs visited reported the need for training of their existing staff in order to refresh and enhance their skills and knowledge in their specific fields of expertise.

In addressing these constraints, the goal should be to remove the long-time absurdity in international agricultural development of having the least paid, least qualified, most poorly housed, and inadequately equipped people at the front line in the field whether they be agronomists, DAs, district nurses or primary school teachers. Such professionals must have status in the community if they are to be effective opportunity makers and takers, and problem-solvers. To achieve this goal it will be necessary to look into, and decide to provide, incentives like zone allowances, educational allowances for children, and health care with transport to the nearest good hospital for people who are willing to take the risk of a responsible position in the field to fulfill the demands of this project.

7.3 Land tenure

The process of updating land use plans and issuing land use holding certificates is well under way in the wereda offices. Feed back from communities on the effectiveness of these activities is satisfactory but the non-existence of a market for farm land is a significant hindrance to the creation of a "living area" by families who want to stay in farming and those families who want to leave the land because their areas are too small or younger family members are not interested in continuing the family tradition. The implementation of improvements to land tenure[9] and arrangements for communal forest land and grazing were also investigated. The outcome helped to improve the interventions under the Natural Resources component and the Forestry and Agro-Forestry sub-components.

7.4 Input supply

The supply of inputs was a major issue during discussions with farmers during the baseline survey and problem identification and ranking by focus groups in the micro-watersheds.

7.4.1 Seed, fertilizer and pesticides

[9] A pilot land administration and registration project, supported by SIDA funds, is underway in Bahir Dar. It is based in EPLAUA. It is operating in the Project areas.

Access to new varieties and viable seed is a major issue. Seed multiplication facilities face resource constraints given the size and importance of agricultural production in ANRS. However, even if good quality seed is made available, access to the watersheds, as discussed elsewhere, and farmer acceptance and uptake will still remain issues.

The Seed Quality Unit in BoARD reported that there are about 6,000 ha contracted out for seed multiplication each year for the whole of ANRS. Precise figures for each type and variety were not available, but about 750 ha of maize; 2,000 ha of wheat; 1,000 ha of teff; 100 ha of oilseed; 500 ha of faba beans; 50 ha of "fodder crop" seed; and 100 ha of barley were targeted for multiplication in 2007. The demand for quality and new varieties of seed is being worked out, more or less, at wereda level (and constrained by the wereda budget) in response to farmer requests.

Discussions in October with the Head of the Agronomy Section in BoARD revealed that the private sector is now being engaged as partners in this important work. Furthermore, the problem of high prices of fertilizer and pesticides was being investigated and work had begun on refining fertilizer recommendations by deriving them from soil analyses.

A programme to increase the production of compost was brought to the Consultant's attention during these discussions. Its purpose is to go some way to solve the problem of declining soil fertility and to alleviate the cost of industrial fertilizer. It has implications for the project because compost will be needed for tree planting in badlands under the Soil and Water Management component.

7.6 Veterinary services

Clearly, institutional support in the form of veterinary services is necessary to implement the BAHS described in **5.2.1** above. The Animal Health Section in BoARD has re-thought its strategy recently. The veterinary services sub-section will now target those diseases which are of high economic importance. The bottleneck, as usual, is a shortage of skilled manpower generally, and veterinarians specifically at wereda level.

One of the economically important diseases being targeted is trypanosomiasis. Out of a total of 128 weredas, 26 have infected animals. The vector, tse tse fly, is only present in 12 of these weredas but the disease is transmitted more widely by other biting flies. Among these weredas are Fogera and Libokemkem which border the project areas and Dera and Mecha which enclose them.

The Animal Health Section is also implementing a new strategy to upgrade existing health posts or to construct new ones. The purpose is to improve accessibility to veterinary services by steadily increasing the numbers of viable health posts from one per seven (7) kebeles and within seven (7) km walking distance to one per three (3) kebeles and within three (3) km walking distance. The interventions planned by the project will fit in with strategy help to achieve its target.

7.7 Provision of credit

The Amhara Credit and Savings Institution (ACSI) is a micro credit organisation. It is successful and has good penetration into the project areas with sub-branches in each wereda. It is focused on lending small amounts of money to individuals (for urban areas) and groups (in rural areas). The rural loans are based on group loans to 5-7 people who are jointly responsible for collateral and repayments. The size of the loan depends on the group. The maximum loan is Birr 5,000 and the minimum is Birr 300. A loan must be repaid over 2 years. Repayment rates have been extremely good at 99.3%. In particular, the loans have been used very effectively by females.

From the perspective of the project, ACSI could be a good source of small loans to the project communities. However, the loan term of 2 years and the ceiling amount of Birr 5,000 will inhibit borrowing for some CAP activities. For example, if a farmer group wished to invest in perennial tree/fruit crops then the pay-back period must be longer than 2 years because most perennial crops begin to provide a return from 3 – 5 years after establishment.

For plantation tree crops, a return is normal after about year 6 or 7. Farmer groups face a different problem with small irrigation schemes. Start-up capital will be usually more than Birr 5,000. Thus, even though the payback period may well start within 1 to 2 years, a group's ability to invest may be hampered at the start.

As ACSI is already functioning successfully, it will be difficult to duplicate a project-based credit service. Therefore, it will be more effective if the project begins a dialogue to adapt the above regulations with ACSI's controlling owner, the National Bank. Small scale irrigation schemes and the planting of perennial crops are important interventions in the project areas. Therefore, the situation needs to be discussed in the early stages of implementation if these interventions are to succeed.

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