EEPCO

ETHIOPIAN ELECTRIC POWER CORPORATION

GIBE III Hydroelectric Project

Level 1 DESIGN

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT
ADDITIONAL STUDY ON DOWNSTREAM IMPACT

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Table of Contents

List of Tables

List of Figures

List of Appendixes

Acronyms and Abbreviations

AfDB	African Development Bank
AFD	Action for Development
ATVET	Agricultural Technical Vocational Education Training
CBPP	contagious Bovine Pleuro-pneumonia
CCPP	Contagious Caprine Pleuro-pneumonia
CHA	Controlled Hunting Area
CSA	Central Statistics Agency
DM	Dry Matter
EBP	Ethiopian Breeders Programme
EEPA	Ethiopian Environmental Protection Agency
EEPCO	Ethiopian Electric Power Corporation
EIA	Environmental Impact Assessment
EMU	Environmental Monitoring Unit (EEPCO)
EPA	Environmental Protection Authority
EPARDA	Ethiopian Pastoralist, Research and Development Association
ESDP	Educational Sector Development Programme
ETP	Education and Training Policy
EWCO	Ethiopian Wildlife Conservation Organisation
EIB	European Investment Bank
FAO	Food and Agriculture Organisation (of the UN)
FDRE	Federal Democratic Republic of Ethiopia
FPME	Fish Production and Marketing Enterprise
FMD	Foot and Mouth Disease
GIS	Geographical Information System
GoE	Government of Ethiopia
GPE	Gastro-Parasitic Enteritis
GPS	Global Positioning System
GTZ	German Cooperation Agency
HH	Household
IBA	Important Bird Area
IFC	International Finance Corporation
ITCZ	Inter-Tropical Convergence Zone
IUCN	International Union for Conservation of Nature
LSD	Lumpy Skin Disease
MNRDEP	Ministry of Natural Resources and Environmental Protection
MoARD	Ministry of Agriculture and Rural Development
MoH	Ministry of Health
NCD	New Castle Disease
NGO	Non Governmental Organization
NTFP	Non-Timber Forestry Product
PA	Peasant Association
PTC	Peasant Training Centre
SC	Service Cooperatives
SNNPRS	Southern Nations, Nationalities and Peoples' Regional State
TLU	Tropical Livestock Unit
USD	United States Dollar
WCD	Wildlife Conservation Department
WB	World Bank
WCD	World Commission of Dams'

0 EXECUTIVE SUMMARY

0.1 Background

The present contribution completes the Environmental Impact Assessment requirements for Gibe III Hydroelectric Project, by furnishing specific elements of knowledge for a better understanding of Gibe III downstream environments, the expected potential impacts that the planned hydropower development may have, and the mitigation measures required in order to minimise / offset such foreseeable consequences on that peculiar natural and social environment, representing an Ethiopian fundamental asset and national heritage value on so many essential accounts.

It is a matter of high national concern to make sure that adequate degrees of protection are guaranteed to local fundamental and widely-recognised diverse natural and human features, while ensuring that national and local developmental interests and priorities are safely and sustainably put in place for the well-being and advancement of Ethiopian society as a whole.

Such a strategic aim will as well have to take into consideration citizen rightful expectations, including those arising from Lower Omo least developed ethnic groups and minorities, in order for them, as Project shareholders, to get their deserved share of GoE developmental actions.

It is by keeping the above inter-related equally-important elements and aspects in mind that the Consultant has endeavoured to assess existing situations, potentials for development, and role / importance that Gibe III development may have in the local environmental, social, and economic context not (only) as an isolated element of disturbance but rather as an important presence whose influence will contribute to shape, one way or another, the future of the region.

0.2 Project Description

The Gibe III Hydropower Project will be the third development in a cascade of water resource schemes (Gilgel Gibe/ Gibe I, in operation and Gibe II under completion) on the main Gibe/Omo River.

The Gibe III Hydropower scheme comprises a 240m high dam which will create a huge reservoir with a surface area of some 200 km^2 and a live storage of some 11,750 million m^3. It has underground and inclined penstocks, a surface powerhouse equipped with ten power generating units and switchyards, with the following characteristics:

- Vertical axis Francis N. 10 turbines, 187 MW (with a total installed capacity of 1,870 MW), 211 m Hn, 95 m^3/s Q
- 0.46 Plant load factor (0.46 Gibe I; 0.44 Gibe II)
- 6,500 GWh Energy produced annually

The electrical power will be available at any time of the day or night to cover both peak and off-peak demand in the Ethiopian interconnected power systems or exported. The so-called specific unit cost of the Gibe III scheme, based on the generation component (excluding the transmission component), is some 2.86 Euro cents per kWh indicative of a very attractive hydropower generation scheme.

0.3 Downstream Environment

Under this approach, the Gibe III *downstream environment* main features have been assessed in their relevant physical (geo-morphological and hydrological aspects, climate, land cover features), biological (flora, fauna, wildlife and Protected Areas resources, aquatic and riverine habitats and known / potential biodiversity characteristics and values) and socio-economic contexts.

Main features of *physical aspects* testify an imbalance in the present Omo River hydrological regime due to both heavy deforestation in the upper watershed and erratic rainfalls contributing to higher peak floods with sudden variations of water levels and frequent floods causing destructive effects on human and animal life, private assets and public infrastructures particularly in the river delta.

Huge evaporation losses as a consequence of excessive, uncontrolled flooding further contribute to the current recession of Lake Turkana.

The *biological environment* is characterised by terrestrial natural vegetation patterns made up of diverse physiognomic and transition / evolution forms due to different local conditions and uneven degrees of anthropogenic disturbance and utilisation.

In these environments factors of environmental stress are represented by extraction of fuelwood, wildfires, and overgrazing by domestic cattle frequently resulting in vegetational degradation and bush encroachment.

Wildlife resources also show worrying diminishing trends in their presence, due to the importance of many species as a source of meat, medicine, skins and hides for local livelihood.

This is also a consequence of the semi-nomadic lifestyle of the population and widespread availability of hunting weapons.

Fluvial and lacustrine biodiversity has also been evaluated at selected locations by Visual Based Rapid Habitat Assessment method, generally showing limited potential biodiversity values (excluding the delta area) mainly due to the high variability of unfavourable conditions of unregulated river flows.

In such conditions the practical absence of vegetation cover along most of river banks due to both excessive flash flows regimes and recession agricultural cultivation practices increases local erosion and contributes to river siltation and water turbidity thus effectively inhibiting photosynthesis for algae development and therefore limiting oxygen formation and hence biodiversity potentials.

The *socio-economic environment* has also been thoroughly reviewed by means of analysing existing information and data, as well as by utilising specific instruments such as field surveys and questionnaires in order to get a sufficiently clear picture of prevailing conditions of local populations and their settlement patterns, ethnic composition, religious and gender issues, present sources of conflict, income and household conditions deriving from traditional agricultural, animal husbandry and fishing practices, and issues of food security and food aid.

Social and administrative settings have been studied as far as Peasant Associations, Co-operatives, and government local institutional structures are concerned.

Such studies have revealed an extremely diverse social and anthropological context, characterised by seasonal inter-regional migration and a number of recurring conflicts and clashes mainly due to competition in the traditional use of dwindling natural assets either in terms of natural vegetation, grazing, hunting and fishing grounds.

In fact, technicalities and relevant characteristics, potentials and constraints of practiced Agriculture, Animal Husbandry and Grazing, and Fisheries have evidentiated a largely backward and primitive concept of land use, in which natural resources are being utilised “at will” without much regard being paid to ensure any sustainability to the utilisation process, in most cases simply exploiting the resource to the best of individual capabilities, given the numerous formidable constraints in terms of adverse environmental conditions in which human beings are forced to dwell.

0.4 Environmental Impacts

Identified *Project Benefits* on water resources are to be found in the possibility to control flooding, thus guaranteeing regularity and yields of downstream human activities, including recession agriculture.

In fact, while large unregulated floods results in severe damages to downstream communities, severe drought periods, such as the ones occurred in the mid eighties, caused famine all over the Lower Omo region.

As such, benefits include a regulatory effect on the hydrologic balance of the Omo River system and Lake Turkana, a diminished impact of un-regulated catastrophic events (floods) on riverine human, animal, and floral communities and habitats, and the possibility to establish infrastructures and human activities, in particular settled agriculture, in many areas previously affected by unregulated floods of uncertain magnitude.

Fluvial, lacustrine, and riparian habitats as well may see their biodiversity values to increase as a consequence of more regulated river flows and consequently stabilised riverbanks.

Riverine and lake fisheries will also be advantaged by the opportunity to efficiently develop, thanks to regulation of the river flow and provision of timely and adequate artificial floods.

Traditional Agriculture will benefit by the avoidance of drought years, thus guaranteeing that adequate, sustainable production is ensured on a regular basis throughout the lower basin and the delta area.
Social services, facilities, and infrastructure will potentially greatly benefit from a regulated river flow, including potential for improved communications amongst downstream Weredas and year-round transportation of people and goods by bridges and improvements in river navigation now made possible throughout the region.

Project *Potential Impacts*, most of which likely to be fully mitigated by the planned water released in terms of environmental flow, high flow and artificial floods of pre-set duration and magnitude, have also been identified on the natural and human local environment.

A certain degree of reduction in the river solid transport downstream of the dam is foreseen, particularly for what concerns its coarse fraction component being now trapped in the reservoir, although a percentage of about 70% of the sediment, made up of extremely fine particles (colloids, clay, fine silt) will remain in suspension and will therefore continue to be carried downstream.

Terrestrial flora of riverine formations will also be affected by reduction in seasonal water level fluctuations if not balanced by artificially-induced limited floods as planned, with potential damages being more concentrated within those narrow formations of the upper portion of the basin which at present get moisture only during periods of increased water presence and floods.

Fish stocks will also potentially be modified and be negatively affected with risks of changing composition and reducing yields in the absence of appropriate mitigation actions such as the designed river flow regulation for environmental protection.

0.5 Mitigation Measures

Planned main *Mitigation Actions* have included a set of physical and managerial measures, standards and guidelines meant to achieve a suitable river flow regulation whose strict implementation will indeed minimise damage to living organisms downstream, as well as permitting local traditional socio-economic activities to perform on the same levels as those on average prevailing at present, while safeguarding from disastrous floods and years (one in three) of crop failures due to insufficient water levels and uncertain duration of occurrence to guarantee recession agriculture taking place.

Amongst the above measures, on the basis of a preliminary analysis, a first attempt to propose a suitable environmental flow and controlled floods has been made.

Under this planned measure, the proposed river regulation different components are designed to attain maximum environmental protection while guaranteeing as many as possible ecological roles and processes so as to ensure natural processes to continue taking place.

The planned river flow regulation includes provisions for a suitable Environmental (base) flow, a high pulse flow, and occurrence of controlled flooding.

Further, provision has also being made for a set of *ancillary mitigation and compensation activities* and other developmental actions, to be implemented by EEPCO and local Authorities and to be possibly financed through the Federal Budget and electricity-originated revenues.

These include Fisheries Supporting Actions, such as improvement of training and extension services for the fishing community, provision of fishing gears and equipment, infrastructure development, and enhancement of sport fishing activities and tourism.

Both rainfed and irrigated agriculture is also targeted for support through actions meant to boost agricultural extension services, agroforestry, water conservation and crop diversification, promote improved crop varieties and pest control techniques, while developing and encouraging smallholder schemes, and small and large scale commercial farms.

The Livestock Sector, due to its local importance is also suggested to be the subject of interventions meant to achieve a broad range of objectives including rangeland development and management, improvement of veterinary services, provision of in-land watering points, forage improvement, and amelioration of local livestock breeds.

Eventually, a further set of actions are planned as confidence-building and socio-economic developmental activities including a community awareness program, the implementation of an information system, co-operative support and agriculture in-service training, co-ordination for food aid, conflict prevention and resolution activities, Wereda institutional strengthening, and EMU capacity building.

0.6 Environmental Management and Monitoring

Eventually, appropriate contribution is provided in terms of overall and specific *Environmental Management and Monitoring Actions* in order to fully adapt Project Management to specific downstream requirements and peculiarities.

An effective organisational set-up concept has been proposed to EEPCO based on three inter-related components: a specific information strategy, a framework for inter-organisational co-ordination measures, and a tailored capacity building programme.

Under the Management and Monitoring arrangements, institutional responsibility sharing is an important factor to be taken into consideration.

Specific indications on the recommended downstream monitoring requirements are also developed for EEPCO consideration, involving appropriate physical, ecological and socio-economic aspects to be investigated both as an in-depth Baseline Survey and periodically thereafter through a feedback mechanism propose corrective measures and actions as necessary.

0.7 Environmental Management and Monitoring Cost

The total environmental mitigation, management, monitoring and training cost amounts to some ETB 281.8 million. The cost estimate has made adequate provisions for contingencies and it has been considered as a component of the financial requirement of the project.

This cost will cover the implementation of various mitigation and compensation measures and these including: development of flood recession agriculture, irrigated agriculture, livestock production, fishery development, socio-economic support programme, installation of flow variation acoustic warning system, and food aid during reservoir filling.

EEPCO is responsible for providing the financial resources required to implement these measures and programmes from the national budget. Marginal benefits from the exploitation of the hydropower development should be set aside for financing the long term financial needs of the social and environmental needs of the downstream area.

1 INTRODUCTION

1.1 Background

The Gibe III Hydroelectric Project is one of the most attractive hydroelectric developments in the region. The Environmental Impact Assessment (EIA) guidelines prepared by the Environmental Protection Authority (EPA) (EPA, 2003) require any development projects to reduce adverse effects on the physical, biological, and socio-economic environments.

In line with this, CESI SpA of Milan, Italy, together with MDI Consulting Engineers of Addis Ababa produced the required EIA Report related to the establishment of the Gibe III Hydroelectric Project.

As far as downstream environmental aspects are concerned, these have been the subject of specific in-depth studies and analysis carried out by Agriconsulting of Italy in association with MDI Consulting Engineers to complete the overall EIA requirements. Results of such investigations are given in the present report.

1.2 Project Location

The Gibe III hydropower dam is located within the Omo Gibe River Basin with approximate geographic coordinates of the dam axis being placed at between 312,044E and 757,343N and 312,542E and 757,107N. The downstream area extends from the dam site down to Lake Turkana.

The main project infrastructure components fall under the jurisdiction of the Mareka Gana Wereda of the Dawro Zone and Kindo Koyisha Wereda of Sodo zone within the Southern Nations and Nationalities People Regional State (SNNPRS) some 400 km South West of Addis Ababa.

There are a total of four administrative Weredas (Salamago, Nyangatom, Hamer and Dasenech) of the South Omo Zone of the SNNPRS that have been considered as potentially affected by the planned developments within the lower Omo River downstream of the Gibe III dam site.

1.3 Objectives

The fundamental objective of the study is to assess the potential impacts that the construction and operation of the Gibe III Hydroelectric Project may induce on the environment and on the communities living in the lower valley of the Omo River, with special reference to social aspects and economic activities that rely on seasonal variations in flows, thus ensuring that the Project is environmentally sound and contributes to the development of social, economical and environmental assets.

It is also expected to provide a means whereby the overall environmental performance of the project can be enhanced through:

- Provision of baseline information on the physical and biological environment and social, cultural, demographic and economic characteristics of the population in the downstream area;
- Identification and evaluation of potential impacts associated with project implementation, and subsequent operation;
- Preparation of scenarios and recommendations regarding measures that will minimize adverse impacts and enhance beneficial aspects; and
- Gather official and community attitudes towards the project and identify potentials and challenges for mitigation strategies.

1.4 Definition of the Study Area

In consideration of the nature and the location of the potential future conditions and consequences of operation, the following study limits were defined within the field investigations:

For the socio-economic survey, agricultural aspects and livestock, different communities along the Lower Omo belonging to the following four downstream Salamago, Dasenech, Nyangatom and Hamer Weredas were included.

For the terrestrial and aquatic ecology, as well as for fisheries, the Omo River downstream of the dam site until its mouth into Lake Turkana was considered.

1.5 Scope, Methodology, and Study Assumptions

The methodology adopted for the environmental study follows the conventional pattern for hydropower projects and meets the requirements of EPA's guidelines and the Environmental Procedures followed by international financing institutions and is summarised below.

<u>Characteristics of the project</u>: A review of the project design, construction and operation has been carried out, with particular reference to establishing main features and scope of planned operational characteristics in order to identify potential consequences of the project on the downstream environment along the Lower Omo River.

<u>Collection of Available Information</u>: Available primary and secondary data from different sources were collected and analysed. Primary data were collected through sample household survey and discussion with informant groups and Peasant Associations. Other knowledgeable informants including PA leaders, clan leaders, elders and development workers provided important socio-economic, biological and cultural information during the course of the field survey.

With regard to the secondary data collection, the main sources of information and data were the Weredas Administration and Agricultural Offices. The concerned Wereda Agricultural Office Heads and experts were consulted on the various development activities of the project site.

As part of the data collection activities the consultant collected and reviewed published relevant National documents as well as CSA's census reports and papers.

Information on existing environmental conditions, necessary to provide the basic background for impact identification and assessment, has been obtained from these published sources.

This downstream impact assessment for the proposed Gibe III Hydroelectric project has been carried out within the framework of local, national and international environmental regulations. The legislative framework applicable to the proposed project is governed by the Federal Democratic Republic of Ethiopia (FDRE) and International Financing Institutions who will be involved in this project and these includes: the African Development Bank (AfDB), the World Bank/ International Finance Corporation (IFC) and the European Investment Bank (EIB). The national and international regulations/conventions/ standards applicable to the construction and operation of the Gibe III Hydroelectric project have been reviewed and presented in the ESIA report.

Topographic maps prepared by the Ethiopian Mapping Agency and Central Statistical Authority as well as satellite imageries were also used to identify and delineate settlements, resources and facilities that could potentially have been affected when the proposed scheme is realized.

The current National and regional conservation area map issued by the Federal Government of Ethiopia has also been used.

<u>Field Investigation</u>: In order to gain first-hand knowledge of existing environmental conditions and to put the proposed design, construction and operation works into context, members of the Study Team have carried out extensive site investigations.

During the field investigation, information on physical resources, ecological resources, economic development activities, socio-economic aspects, health, cultural and other values in the project area has been collected.

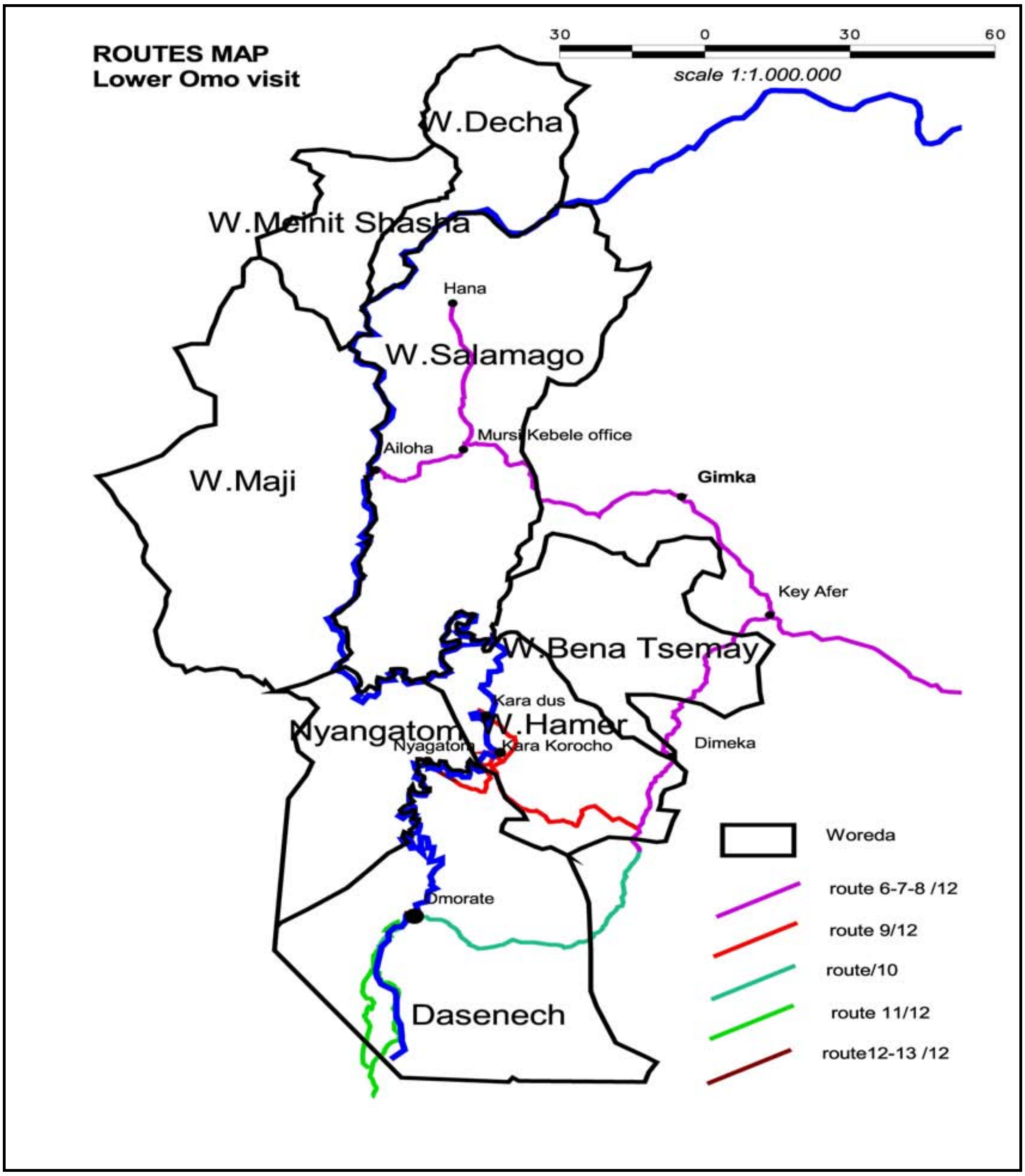


Figure 1.1: Routes covered by the mission, 6 to 13 December 2007

Public Consultation: The field investigation also included consultation with various community members along the Omo River, as well as different stakeholders and local authorities in the project area. The consultation was meant to obtain supplementary information on social, socio-economic and socio-cultural conditions, and gather views on various aspects of the project. It also included collection of background information relevant to impact assessment (in particular, to identify any areas of specific concern which needed to be addressed in this assessment) and identification of suitable mitigation measures.

Description of the Existing Environment: Baseline data on the current status of the physical, biological and socio-cultural environment of the study area have been assembled, evaluated and presented.

<u>Identification of Environmental Impacts</u>: Key potential positive and adverse impacts on the physical, biological and socio-economic environment associated with the operation phase of the project have been identified and evaluated.

<u>Environmental Mitigation and Benefit Enhancement Measures</u>: Feasible and cost effective mitigation and benefit enhancement measures that may reduce potentially adverse environmental impacts during operation phases of the project to acceptable levels are recommended.

<u>Environmental Management and Monitoring requirements</u>: Further elements to be considered within the existing main EIA environmental management and monitoring procedures have been developed.

<u>Elaboration of the Study report</u>: The final step has then been the preparation of the Downstream Additional Study Report which addresses items called for in the Main EIA report, as well as those which were brought to the team's attention by the local communities and other organizations.

The report has thus concentrated on key issues and potential impacts which are of importance in terms of affecting overall environmental performance of the project. It answers such essential questions in a quali-quantitative manner at the reconnaissance level, consequently establishing the framework for a better assessment of likely future scenarios mainly meant to enhance project benefits for the downstream communities.

Eventually, the present analysis sets off under the working assumption that the Gibe III Hydropower Development Scheme, once operational, will cause to a considerable extent *a substantial degree of regulation to the Omo river yearly flow regimes (compared with the current situation), greatly diminishing seasonality of flows and excessive monthly water level variations, and practically confining year-round water flows within river banks, with the only exception of artificially created controlled annual floods to occur for pre-set periods of time.*

Such a controlled flood (managed flood release) is specifically planned to offset, as much as possible, negative impacts that may occur, in its absence, to the present socio-economical peculiar lay-out of the area, especially concerning human activities taking place within the riverine habitat (recession agriculture and seasonal livestock grazing grounds).

Another planned objective of the artificial flood will be to fend-off potential negative consequences of flow regularisation on lacustrine habitats and riparian woodland formations under an ecosystem approach to be undertaken at the appropriate spatial and temporal scale.

As far as possible in its planning and execution the Study has duly considered in the course of its unfolding, the World Commission on Dams' (WCD) recommendations in terms of Strategic Priorities and proposed mitigation actions, with specific reference to technicalities of overall approach and artificial flood releases.

In particular for:

Strategic Priority 1: Gaining Public Acceptance; The team has made sure that local stakeholders (see relevant Section within the text) at Wereda, PA and Village levels have been thoroughly involved and informed, taking active part in the gathering of data (questionnaires at several levels), and following discussions on potential consequences and mitigation options.

Strategic Priority 2: Comprehensive Options Assessment; Local development needs and objectives have been extensively discussed and analysed in light of available options for both environmental protection as well as socio-economic developmental options (eg. agriculture, livestock, fisheries, tourism, etc) of the concerned populations.

Strategic Priority 3: Addressing Existing Dams; Consequences, benefits and constraints arising from the operation of major existing dams in Africa (Zimbabwe, Mozambique, Kenya, South

Africa, Senegal), especially operating in previous recession agriculture contexts have been taken into account in order to maximise lessons and experiences.

Strategic Priority 4: Sustaining Rivers and Livelihoods: This study represents a contribution required to increase knowledge on the Lower Omo socio-economic, anthropologic, and biological environment and its values, functions, and requirements.

It is on the basis of this analysis that suitable environmental flow and controlled floods have been made. The proposed river hydraulic model and outcomes of the Environmental Monitoring Plan will permit to optimise the required controlled flow.

Strategic Priority 5: Recognising Entitlements and Sharing Benefits: The Study has been specifically targeted at the recognition and safeguard of local populations' way of life and rights, including the assessment of all relevant features of local semi-nomadic and riverine-settled ethnic groups.

Strategic Priority 6: Ensuring Compliance; Environmental compliance indications and guidelines for project partners have been included in both the present Study and CESI main EIA Report.

Strategic Priority 7: Sharing Rivers for Peace, Development and Security; Under the present approach, Kenya is considered a partner of the transboundary developmental process not only as the main target for produced hydroelectric power, but also for environmental benefits accruing to Lake Turkana, to the hydrological balance of which the Omo River contributes to a substantial part (see further down in the text).

1.6 Report Structure

The report has been developed keeping in mind Ethiopia's Environmental Protection Authority's guidelines for preparing environmental impact assessments and it comprises different parts describing all the key elements considered as being required to assess potential effects generated from the realization of the Gibe III hydroelectric project on the downstream environment.

Under such assumptions,

- Chapter 1 constitutes the introduction and furnishes information on the objectives, scope and methodology for carrying out the study;
- Chapter 2 gives an account of the main physical, biological and socio-economic environments within the downstream Gibe III Hydroelectric Project Area;
- Chapter 3 discusses major potential environmental impacts having the objective to define where these impacted areas may be localised and which are the items that need attention, so that benefit enhancement and mitigation measures may be properly addressed during design implementation, construction and operation phases;
- Chapter 4 relates to the objectives, methodology and results of the process of information applied vis-à-vis general public and stakeholders;
- Chapter 5 elaborates on required foreseeable actions and mitigation measures;
- Chapters 6 and 7 furnish elements for appropriate environmental management and monitoring activities respectively;
- Chapter 8 presents the costs associated with the different environmental mitigation, management, monitoring and training actions.
- Chapter 9 of the report contains the conclusions and recommendations.

Tables, figures, appendixes and list of references are incorporated in the present Study report.

2 PROJECT DESCRIPTION

2.1 Background

The Omo-Gibe basin is one of the significant surface water resources of Ethiopia. The Gibe cascade project is one of the most attractive potential hydroelectric developments in the country and it has been selected by EEPCO as one of its key hydroelectric development areas.

In subsequent studies various several options were considered for the Gibe river development plan and as a result hydro-projects in series along the main Gibe River in a cascade style were proposed. The general layout of the Gibe cascade plan is shown in Figure 2.1. These four projects are shown in the longitudinal profile in Figure 2.2, from upstream to downstream and summarized below.

The Gibe III hydroelectric project is a third stage of the Gibe hydroelectric cascade scheme on the Greater Gibe River which includes three other schemes. The Gibe III scheme is designed to generate 6,400 GWh of electricity with an installed capacity of 1,870 MW.

Scheme	Installed Capacity	Firm Energy	Status
Gibe I	184 MW	722 GWh/year	in operation
Gibe II	420 MW	1,635 GWh/year	under construction
Gibe III	1,870 MW	6,500 GWh/year	under construction
Gibe IV	2000 MW	8,000 GWh/year	Planning stage

2.2 Description of the Main Project Components

2.2.1 Project Layout

The Gibe III reservoir (from the powerhouse of Gibe II to the dam of Gibe III) is about 155 km long. The only large river entering into the Omo/Gibe is the Gojeb (on the right side). The valley is very narrow and deep canyon and only in two zones the valley is relatively wider.

The morphology of the Gibe-Omo is favourable for the creation of large reservoir and has been used for the selection of the Gibe III dam site.

Figure 2.3 shows the overall layout of the Gibe III scheme and the scheme consists of a dam, underground penstocks, an indoor powerhouse equipped with ten power generating units and switchyards. The works concerning the construction of the Gibe III hydroelectric project are concentrated in a small area of about 1 Km^2.

The data sheet (project characteristics) for the Gibe III Hydroelectric project is presented in Table 2.1 and it summarises the project location and the technical parameters for the civil, mechanical and electrical works.

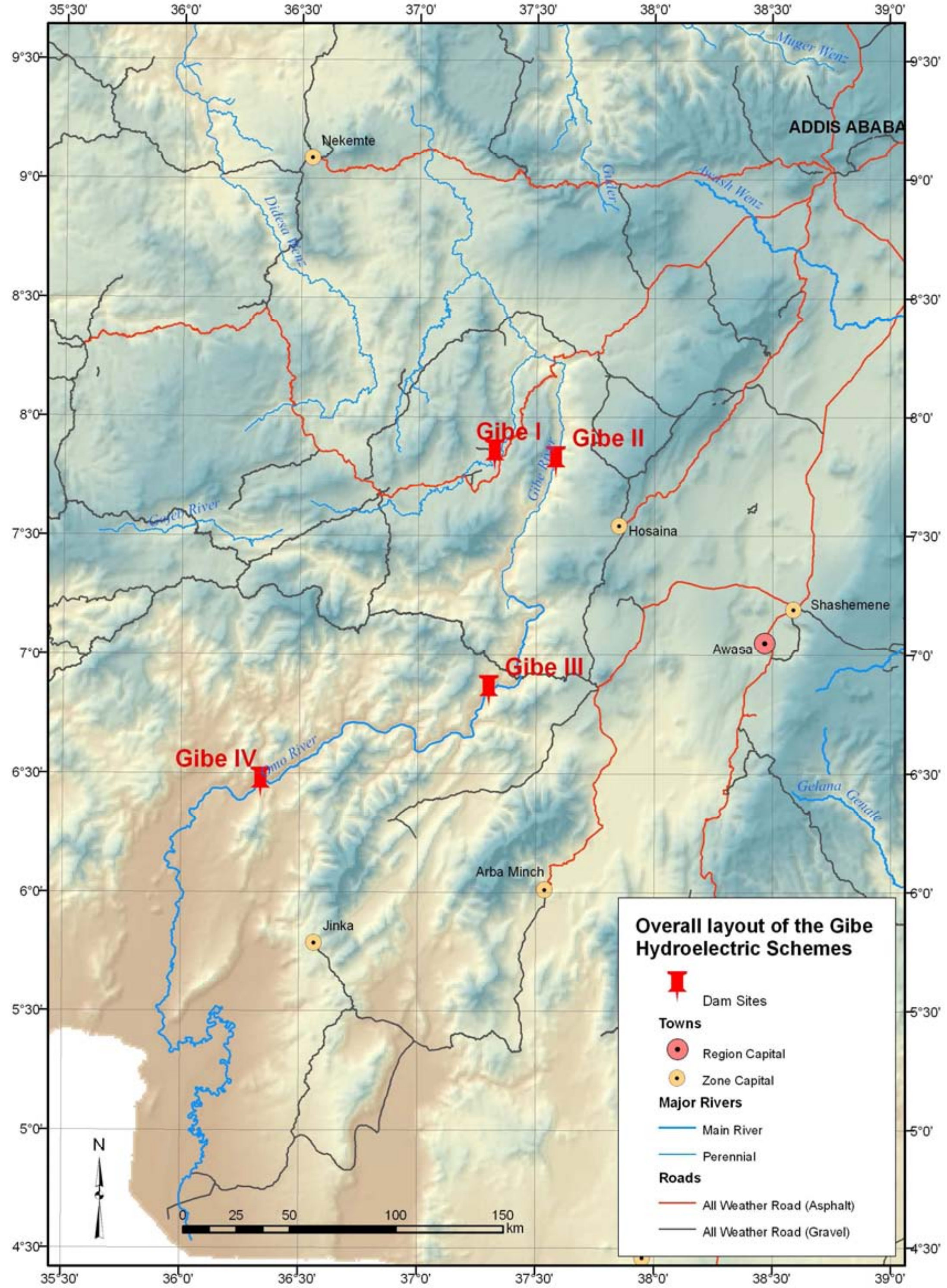


Figure 2.1: Overall layout of the Gibe Hydroelectric Scheme

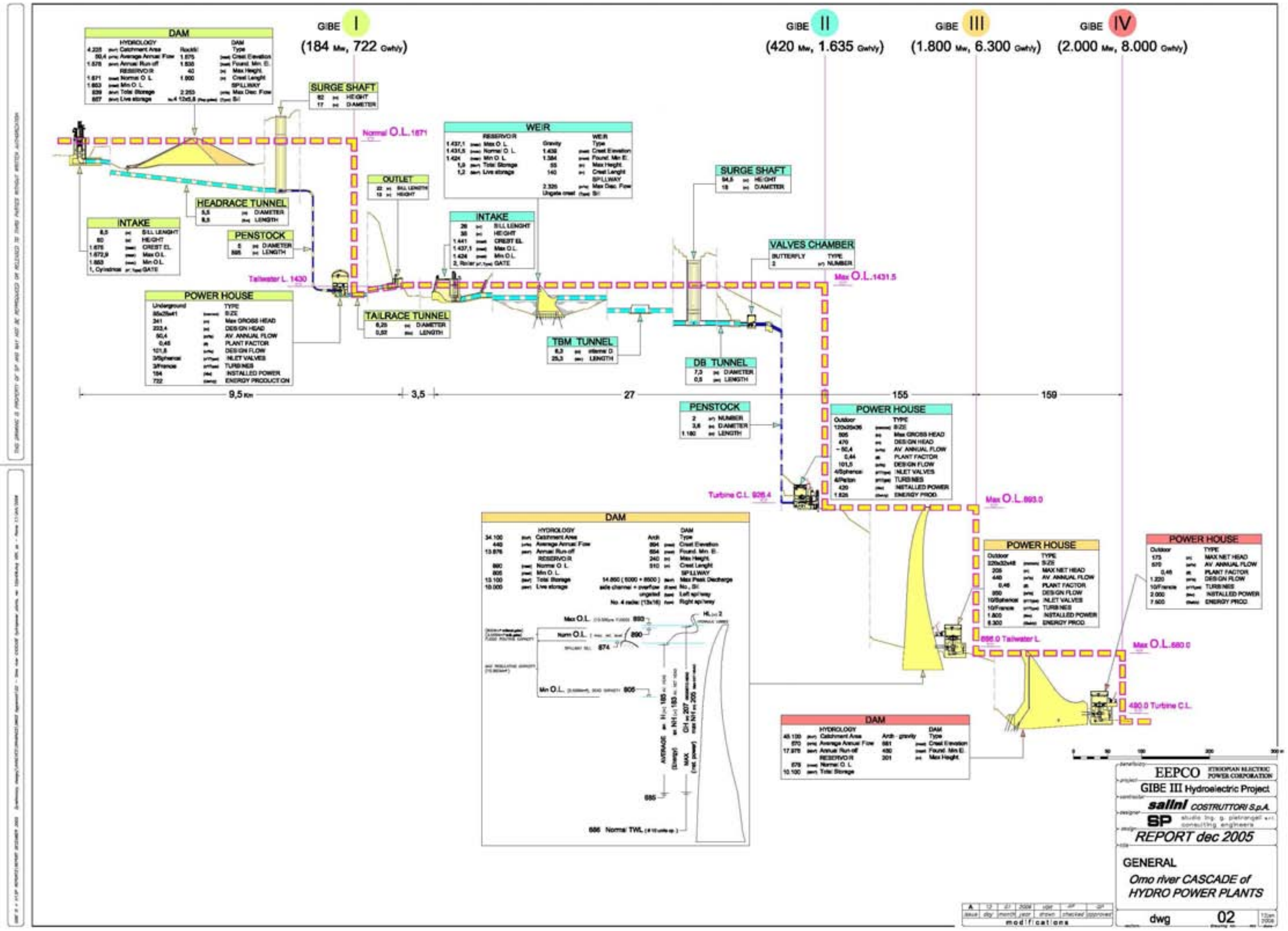


Figure 2.2: General Layout of the Gibe Cascade

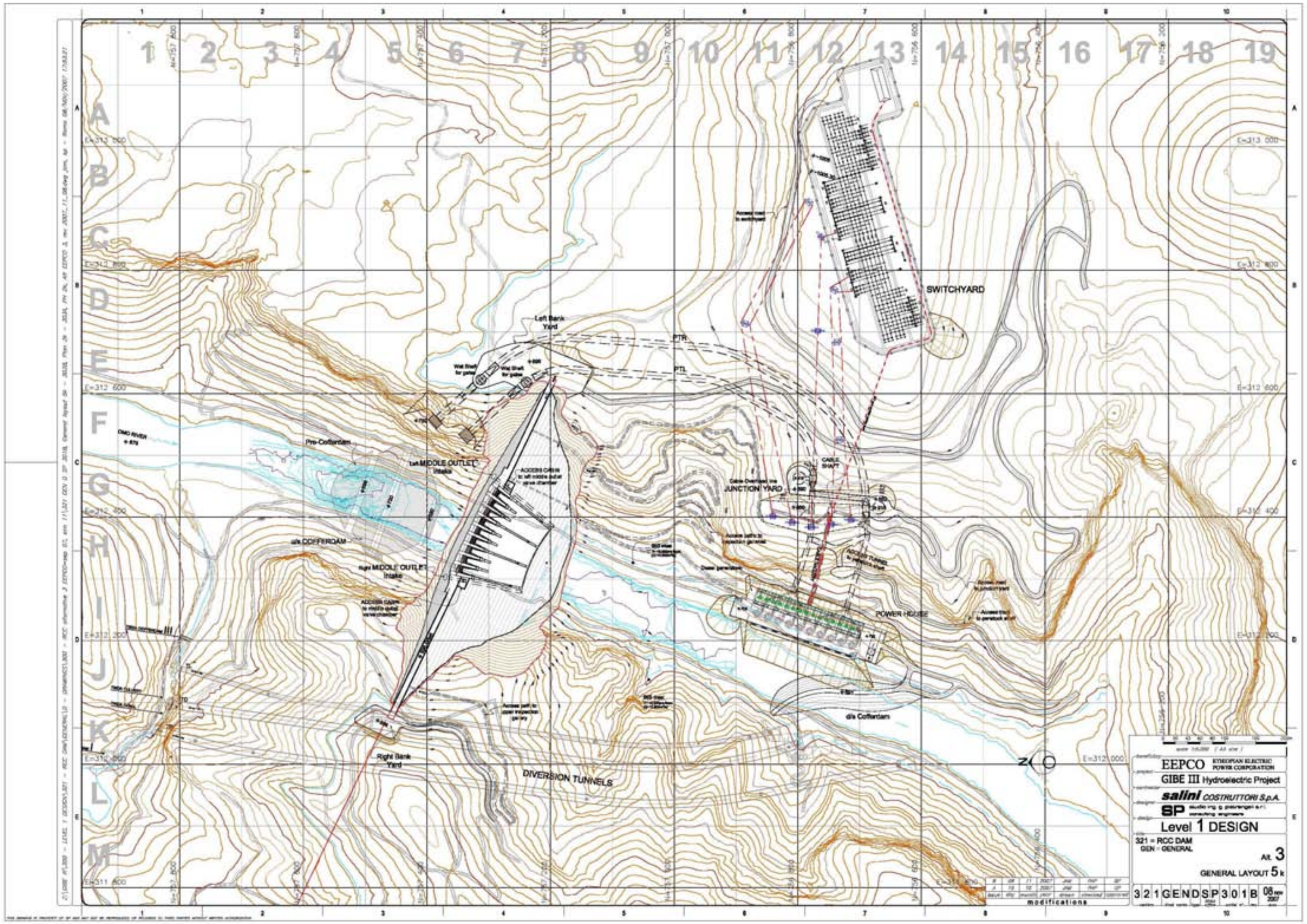


Figure 2.3: General Layout of the Site Installations

Table 2.1: Summary of Main Characteristics of the Project

Gibe III Dam and Reservoir	
Dam	
Dam Type	Roller compacted concrete (RCC) dam
▪ Foundation elevation	665 m i.e.
▪ Height above river bed elevation	231 m
▪ Crest elevation	896 m a.s.l
▪ Crest length	580 m
Reservoir	
Catchment area	34,150 km^2
Minimum operating level	800 m a.s.l
Normal operating level	889 m a.s.l
Maximum water level in the reservoir	892 m a.s.l
Extreme flood level in the reservoir (PMF)	892.5 m a.s.l
Live storage volume	11,750 Mm^3
Surface area at normal operating level	200 km^2
Average annual runoff	438.2 m^3/s
10,000 years return peak flood	10,600 m^3/s
Mean annual sediment yield	18.3 Mm^3/y
River Diversion	
Diversion tunnel (No, D)	3, 7/13.5
Cofferdam Crest Elv.	720 m a.s.l
Design flood	5,200 m^3/s
Spillway	
Type	Ungated (side channel) +gated (overflow)
Radial gate (No. Wx4)	4,135x17.5 #, m
Design flood/safety check flood	10,600/18,660 m^3/s
Outlet works	
Operating level (bottom and mid-level)	750/820,805/889 m a.s.l
Maximum discharge (bottom mid-level)	700/1150 m^3/s
Reservoir lowering period	5 months
Powerhouse	
Powerhouse type	Outdoor
Dimension (WxLxH)	250x46x55 m
Power Generation	
Max. Net Head	211 m
Average Net Head	186 m
Design flow	950 m^3/s
Plant load factor	0.46
Installed power	1,870 MW
Average energy production	6,500GWh/y
Switchyard and Transmission Line	
Switchyard type	Outdoor
Rated voltage	400 kV
Transmission line length	65 km to Sodo substation
Roads	
Site temporary and permanent access road	100 km
Chida -Sodo Relocation roads	80 km

2.2.2 Dam and Reservoir

Dam

Dam design studies have been undertaken to develop the layout of the least-cost dam that will meet internationally recognised safety standards. These design studies have drawn information from the site topographic surveys, the hydrological studies, the geological and geotechnical investigations, the seismic, the reservoir operation and the cost studies.

Different dam types were investigated and finally RCC type dam has been selected with an upstream impervious facing provided by either an asphalt membrane or a concrete slab. The approximately 231 m high Gibe III dam is located at a relatively narrow valley section.

Reservoir

The project aims to dam the Omo River thereby creating a reservoir with a total live storage of about 11,750 Mm^3 and a total surface area of 200 km2 at normal operating level (889 m a.s.l). The minimum operating level is 800 m a.s.l, and the reservoir is approximately 155 km in total length.

The catchment area is about 34,150 Km2. The reservoir level will rise during the rainy season (June to September) and draws down during the dry season.

The very large reservoir volume, together with the kind of spillways adopted, make it possible to control the floods in safe condition.

2.2.3 Power Intakes and Power House

The power intakes are located on the left bank. Two inlet structures, two headrace tunnels and two penstocks will feed 5 powerhouse units each.

The power house will be located along the river, on the left bank and the power house structure will have an approximate size of 250m x 46m x 55m.

The hydrological study indicates that the design flow is 950m3/s.

The 10 generating units have been selected taking in consideration the characteristics of the Ethiopian grid, thus overruling the economic advantage of opting for a reduced number of larger units.

2.2.4 Switchyards

The generators are twin coupled to three windings 15 kV / 400 kV main step-up transformers. In order to limit size and weight of equipment to be transported to site, five banks of three single phase and three windings step-up transformers are proposed. Five, three phase overhead lines connect the Power House to the switchyard.

The switchyard is equipped with a double bus bar scheme as adopted in other recent power plants like Gilgel Gibe II and Beles. Therefore, there will be a total of ten (10) bays plus one spare. The overall dimensions of the switchyard layout are approximately 300 m by 100 m, with a distance between bays of 22 m.

2.2.5 Transmission Line

The power produced by the 1,870 MW powerhouse at Gibe III will be delivered to inter connected system (ICS) through a 400 kV transmission line to the following substations:

- 65 km; two 400 KV double Circuit transmission lines from Gibe III to Wolayita Sub station
- 120 km; 400 KV Single Circuit transmission line from Wolayita Sub station to Gilgel Gibe II Substation;
- 314 km; 400 KV Double Circuit transmission line from Wolayita Sodo to Sebeta Substation No.2; and
- 383 km; 400 KV double Circuit transmission line from Wolayita Sodo to Mega which is the main feeder to Mega-Nairobi connection

2.3 Access Roads

Site access roads will be required to provide all weather access to channel all the traffic generated by the construction activities for the safe transport of personnel, materials and equipment both during construction and operation. Most of them will be used only during construction, since they will be inundated by the reservoir. By the construction of these site access roads the external traffic and the site traffic have be separated. In addition to providing access to the construction activities, the road will greatly benefit the local community by making the transport of people and produce safer, easier and quicker.

Direct access roads to the dam and powerhouse site did not actually exist, consequently two new roads were required, one on the Right bank (road R-1) and one on the Left bank (road L-1) of the Omo River

The first one starts from the Chida - Sodo Road near Kindo Halale village, reaches the SP_1 temporary camp on the plateau, then goes down to the dam site at river level and goes up to the right plateau. The second one starting from the Chida - Sodo Road and follows the Omo River at low level, reaches the dam site at river level and then goes up to the left plateau.

The existing bridge across the Omo River (on the Chida-Sodo road) will be submerged by the future Gibe III reservoir and therefore a new bridge will be required. This new road bridge will be built downstream of the dam.

The detailed design of the road is illustrated in the relevant reports currently being under completion.

2.4 Construction Materials

The Gibe III dam is a RCC type and the scheme will require huge quantities of quarry material for various project uses, such as the main dam, spillway, power station, intake structure, tunnels, access road, various temporary and permanent camps, etc. Several material sites can be used for construction. These material sites are shown in Figure 2.4

2.5 Disposal Areas

The disposal areas for excavated materials are planned downstream of the dam site and others within the borders of future reservoir. The locations of disposal sites are indicated in Figure 2.5 which also shows the construction facilities. These disposal areas are going to be inundated by the reservoir as well.

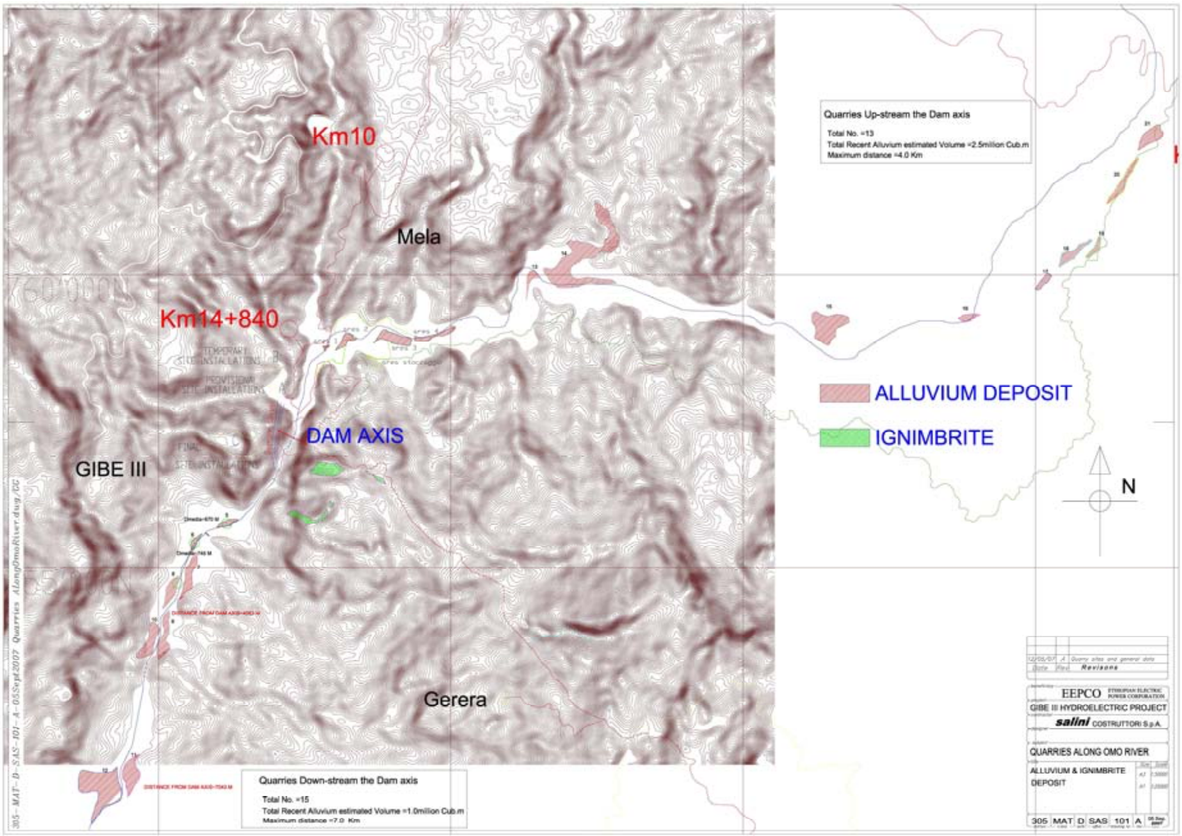


Figure 2.4: Construction Material Sites – Quarries Along Omo River

2.6 Construction and Operation Labour Requirements

Construction and operation of the scheme will provide employment and career opportunity for several thousands of local people.

The initial personnel requirement during construction is approximately 1,200, while at peak construction periods approximately 5,000 personnel will be employed on the project. The number of skilled (technical and administrative) workers will be around 1000 in the construction phase at peak periods. The number of semi-skilled and unskilled workers, including the workers for supporting services will reach about 4000 in the peak construction periods.

EEPCO will be responsible for the operation and maintenance of the plant. During the operation phase, approximately 200 staff persons are needed to operate the power plant and the auxiliary facilities of the dam. Around 50 of these will be highly skilled staff (engineers, mechanics, hydromechanics, electricians, electronics specialists) and administrative staff, and the remaining will be unskilled workers and support staff (guards, cooks, gardeners, etc) who will, preferably, be hired locally.

2.7 Camps and Construction Facilities

The construction workforce peaks just two years into the project with a maximum of more than 5,000. Of the latter a substantial part will be local personnel. The planned camp facilities will house local and international staffs. Figure 2.6 shows the construction campsites.

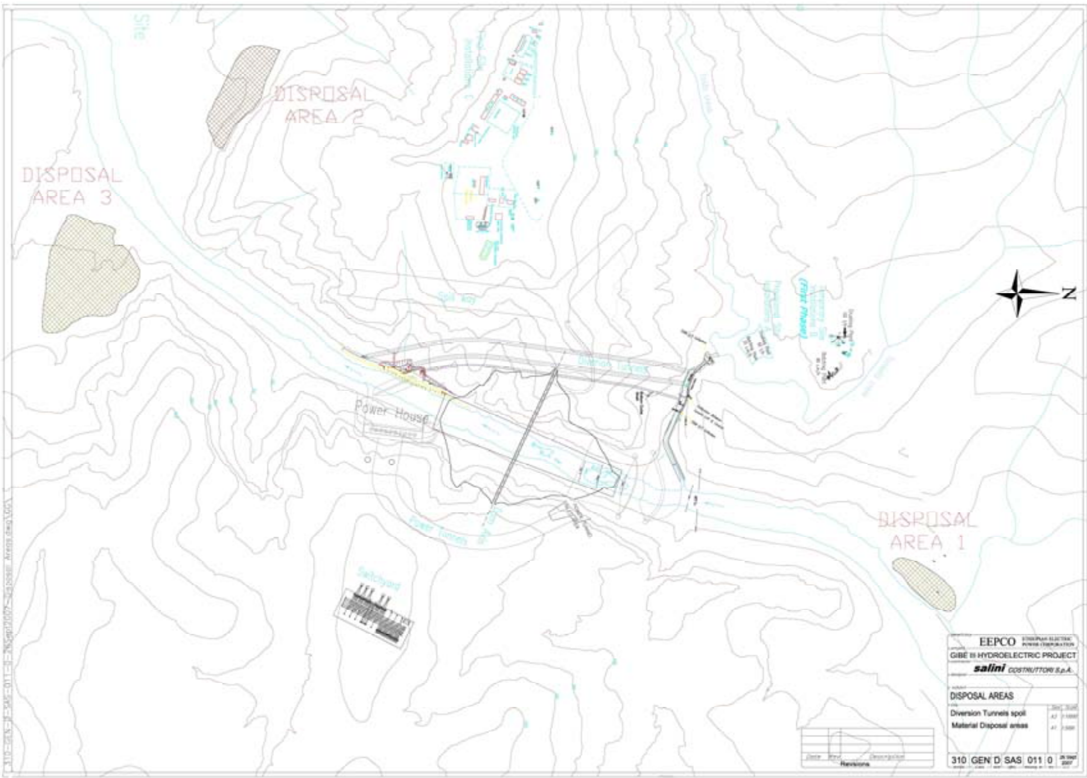


Figure 2.5: Spoil Disposal Sites

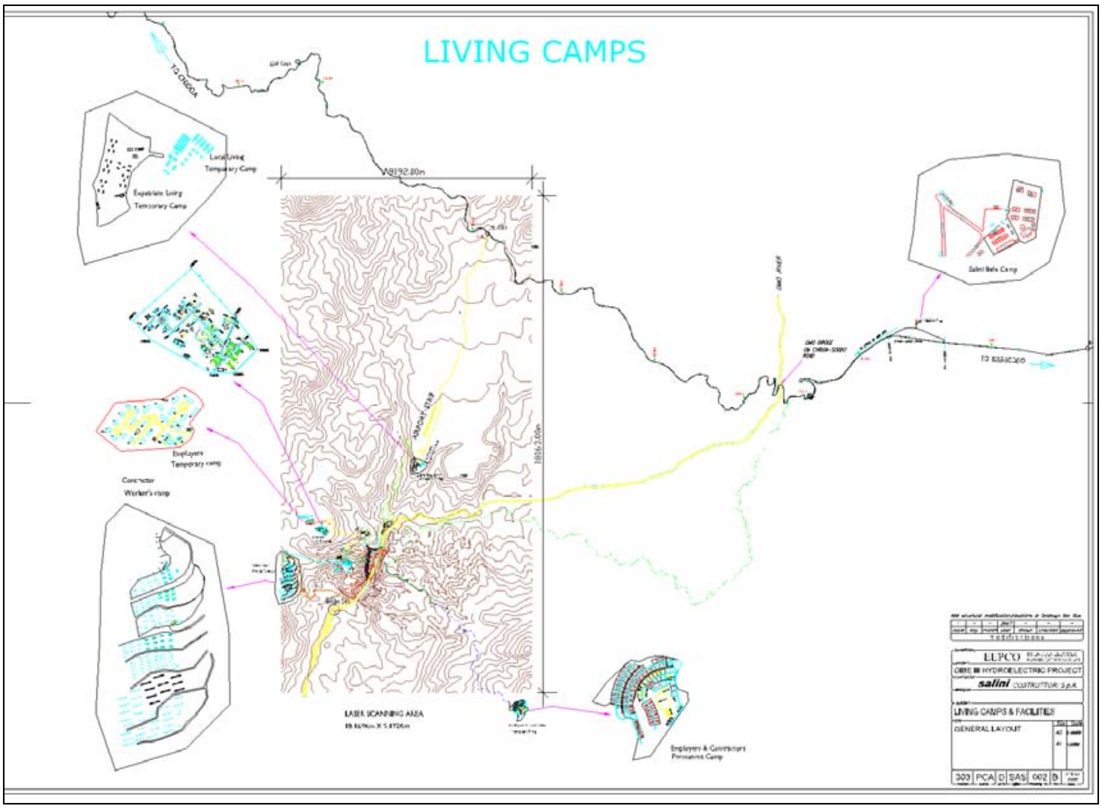


Figure 2.6: Living Camps for Construction Workers

2.8 Project Costs

The total costs of the Gibe III scheme are estimated at 1.55 Billion EUR. This total includes the costs of the construction works, equipment, engineering and administration services. If the total project cots, some 36% will be in local currency and the remainder in foreign currency. Cost for implementing the environmental mitigation, management and monitoring programmes have been estimated and the total costs amount to some Birr 445.2 million. Out of this, approximately ETB 281.8 million will be allocated to cover implementation of the downstream environmental mitigation, management, monitoring programmes. This figure has been considered as a component of the financial requirements of the project.

2.9 Economic

An analysis comparing the total costs of the hydroelectric scheme with the costs of constructing and fuelling the least cost equivalent thermal alternative, a cost-benefit ratio of 1.15 at a discount rate of 10%.

In financial terms, the scheme could generate energy at some use 2.86 Euro cents/kWh. This is an indicative of a reasonably attractive hydroelectric scheme.

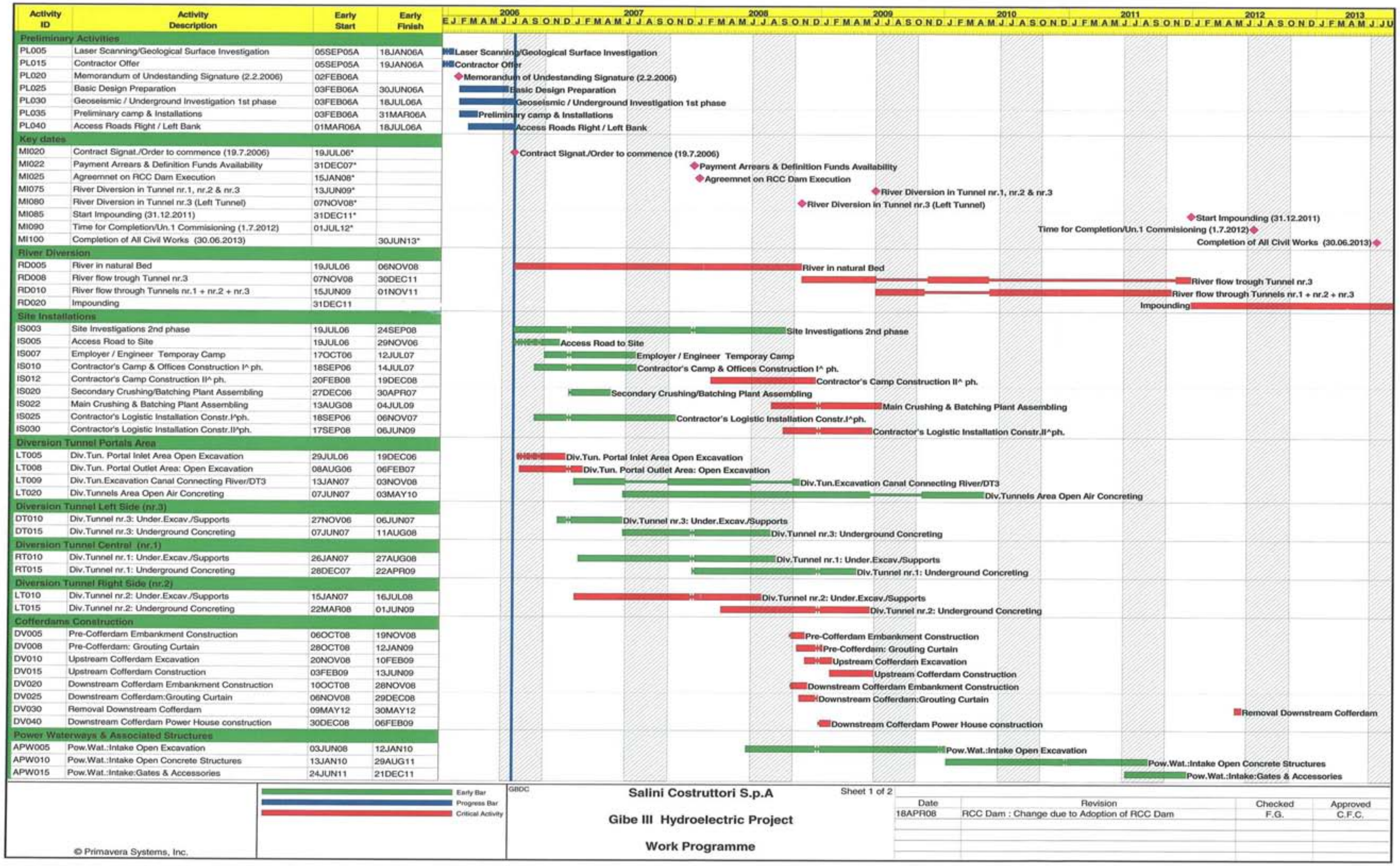
2.10 Construction Programme

Construction of the Project begun in January 2006 and will take more than five years to complete. It could thus be in operation by the beginning of the year 2012. The power and energy generated will be available for industrial, commercial and domestic consumption thereby improving both social and economic conditions in the country.

Neighbouring countries are poorly endowed with water resources that can be converted to inexpensive energy and they face the continuing prospect of increasing oil import in order to meet their own domestic demand. With the implementation of Gibe III hydroelectric project, there will be surplus generation of energy which can be exported to earn much needed foreign exchange, in line with Ethiopia’s Energy Policy.

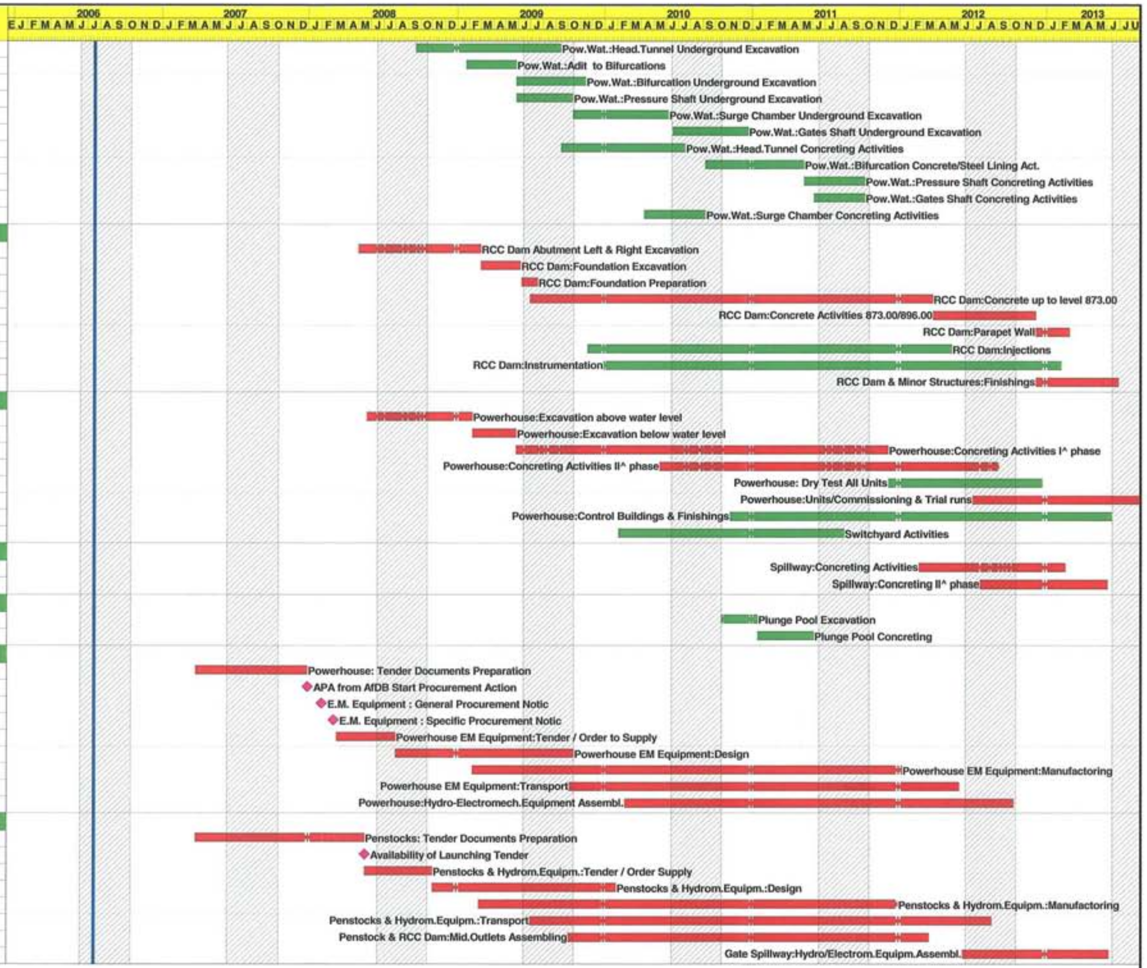
The construction schedule is presented in Figure 2.7.

Figure 2.7: Construction Schedule



Activity ID	Activity Description	Early Start	Early Finish
Preliminary Activities			
PL005	Laser Scanning/Geological Surface Investigation	05SEP05A	18JAN06A
PL015	Contractor Offer	05SEP05A	19JAN06A
PL020	Memorandum of Undestanding Signature (2.2.2006)	02FEB06A	
PL025	Basic Design Preparation	03FEB06A	30JUN06A
PL030	Geoseismic / Underground Investigation 1st phase	03FEB06A	18JUL06A
PL035	Preliminary camp & Installations	03FEB06A	31MAR06A
PL040	Access Roads Right / Left Bank	01MAR06A	18JUL06A
Key dates			
MI020	Contract Signat./Order to commence (19.7.2006)	19JUL06*	
MI022	Payment Arrears & Definition Funds Availability	31DEC07*	
MI025	Agreemnet on RCC Dam Execution	15JAN08*	
MI075	River Diversion in Tunnel nr.1, nr.2 & nr.3	13JUN09*	
MI080	River Diversion in Tunnel nr.3 (Left Tunnel)	07NOV08*	
MI085	Start Impounding (31.12.2011)	31DEC11*	
MI090	Time for Completion/Un.1 Commisioning (1.7.2012)	01JUL12*	
MI100	Completion of All Civil Works (30.06.2013)		30JUN13*
River Diversion			
RD005	River in natural Bed	19JUL06	06NOV08
RD008	River flow trough Tunnel nr.3	07NOV08	30DEC11
RD010	River flow through Tunnels nr.1 + nr.2 + nr.3	15JUN09	01NOV11
RD020	Impounding	31DEC11	
Site Installations			
IS003	Site Investigations 2nd phase	19JUL06	24SEP08
IS005	Access Road to Site	19JUL06	29NOV06
IS007	Employer / Engineer Temporay Camp	17OCT06	12JUL07
IS010	Contractor's Camp & Offices Construction I^ ph.	18SEP06	14JUL07
IS012	Contractor's Camp Construction II^ ph.	20FEB08	19DEC08
IS020	Secondary Crushing/Batching Plant Assembling	27DEC06	30APR07
IS022	Main Crushing & Batching Plant Assembling	13AUG08	04JUL09
IS025	Contractor's Logistic Installation Constr.I^ph.	18SEP06	06NOV07
IS030	Contractor's Logistic Installation Constr.II^ph.	17SEP08	06JUN09
Diversion Tunnel Portals Area			
LT005	Div.Tun. Portal Inlet Area Open Excavation	29JUL06	19DEC06
LT008	Div.Tun. Portal Outlet Area: Open Excavation	08AUG06	06FEB07
LT009	Div.Tun.Excavation Canal Connecting River/DT3	13JAN07	03NOV08
LT020	Div.Tunnels Area Open Air Concreting	07JUN07	03MAY10
Diversion Tunnel Left Side (nr.3)			
DT010	Div.Tunnel nr.3: Under.Excav./Supports	27NOV06	06JUN07
DT015	Div.Tunnel nr.3: Underground Concreting	07JUN07	11AUG08
Diversion Tunnel Central (nr.1)			
RT010	Div.Tunnel nr.1: Under.Excav./Supports	26JAN07	27AUG08
RT015	Div.Tunnel nr.1: Underground Concreting	28DEC07	22APR09
Diversion Tunnel Right Side (nr.2)			
LT010	Div.Tunnel nr.2: Under.Excav./Supports	15JAN07	16JUL08
LT015	Div.Tunnel nr.2: Underground Concreting	22MAR08	01JUN09
Cofferdams Construction			
DV005	Pre-Cofferdam Embankment Construction	06OCT08	19NOV08
DV008	Pre-Cofferdam: Grouting Curtain	28OCT08	12JAN09
DV010	Upstream Cofferdam Excavation	20NOV08	10FEB09
DV015	Upstream Cofferdam Construction	03FEB09	13JUN09
DV020	Downstream Cofferdam Embankment Construction	10OCT08	28NOV08
DV025	Downstream Cofferdam:Grouting Curtain	06NOV08	29DEC08
DV030	Removal Downstream Cofferdam	09MAY12	30MAY12
DV040	Downstream Cofferdam Power House construction	30DEC08	06FEB09
Power Waterways & Associated Structures			
APW005	Pow.Wat.:Intake Open Excavation	03JUN08	12JAN10
APW010	Pow.Wat.:Intake Open Concrete Structures	13JAN10	29AUG11
APW015	Pow.Wat.:Intake:Gates & Accessories	24JUN11	21DEC11

Activity ID	Activity Description	Early Start	Early Finish
APW020	Pow.Wat.:Head.Tunnel Underground Excavation	20SEP08	14SEP09
APW022	Pow.Wat.:Adit to Bifurcations	24JAN09	25MAY09
APW025	Pow.Wat.:Bifurcation Underground Excavation	26MAY09	12NOV09
APW030	Pow.Wat.:Pressure Shaft Underground Excavation	26MAY09	13OCT09
APW035	Pow.Wat.:Surge Chamber Underground Excavation	14OCT09	07JUN10
APW040	Pow.Wat.:Gates Shaft Underground Excavation	19JUN10	20DEC10
APW070	Pow.Wat.:Head.Tunnel Concreting Activities	15SEP09	17JUL10
APW075	Pow.Wat.:Bifurcation Concrete/Steel Lining Act.	07SEP10	10MAY11
APW085	Pow.Wat.:Pressure Shaft Concreting Activities	11MAY11	06OCT11
APW095	Pow.Wat.:Gates Shaft Concreting Activities	03JUN11	06OCT11
APW096	Pow.Wat.:Surge Chamber Concreting Activities	08APR10	06SEP10
RCC Dam Activities			
DM005	RCC Dam Abutment Left & Right Excavation	29APR08	27FEB09
DM010	RCC Dam:Foundation Excavation	28FEB09	06JUN09
DM015	RCC Dam:Foundation Preparation	08JUN09	17JUL09
DM020	RCC Dam:Concrete up to level 873.00	01JUL09	22MAR12
DM025	RCC Dam:Concrete Activities 873.00/896.00	23MAR12	06DEC12
DM035	RCC Dam:Parapet Wall	07DEC12	27FEB13
DM093	RCC Dam:Injections	18NOV09	10MAY12
DM096	RCC Dam:Instrumentation	28DEC09	07FEB13
DM099	RCC Dam & Minor Structures:Finishings	07DEC12	29JUN13
Powerhouse Activities			
PH005	Powerhouse:Excavation above water level	22MAY08	06FEB09
PH008	Powerhouse:Excavation below water level	07FEB09	26MAY09
PH010	Powerhouse:Concreting Activities I^ phase	27MAY09	03DEC11
PH015	Powerhouse:Concreting Activities II^ phase	17MAY10	05SEP12
PH020	Powerhouse: Dry Test All Units	05DEC11	21DEC12
PH025	Powerhouse:Units/Commissioning & Trial runs	02JUL12	
PH040	Powerhouse:Control Buildings & Finishings	08NOV10	14JUN13
SW003	Switchyard Activities	04FEB10	18AUG11
Spillway Activities			
SR010	Spillway:Concreting Activities	17FEB12	16FEB13
SR020	Spillway:Concreting II^ phase	20JUL12	01JUN13
Plunge Pool			
PP005	Plunge Pool Excavation	16OCT10	13JAN11
PP010	Plunge Pool Concreting	14JAN11	02JUN11
Electromech.Equipment Activities			
EM002	Powerhouse: Tender Documents Preparation	26MAR07	26DEC07
EM004	APA from AfDB Start Procurement Action	27DEC07*	
EM010	E.M. Equipment : General Procurement Notic	31JAN08*	
EM015	E.M. Equipment : Specific Procurement Notic	29FEB08*	
EM025	Powerhouse EM Equipment:Tender / Order to Supply	07MAR08	31JUL08
EM030	Powerhouse EM Equipment:Design	01AUG08	14OCT09
EM035	Powerhouse EM Equipment:Manufactoring	07FEB09	05JAN12
EM040	Powerhouse EM Equipment:Transport	05OCT09	26MAY12
PH012	Powerhouse:Hydro-Electromech.Equipment Assembl.	18FEB10	11OCT12
Hydromech.Equipment Activities			
AS002	Penstocks: Tender Documents Preparation	26MAR07	14MAY08
AS004	Availability of Launching Tender	15MAY08	
AS005	Penstocks & Hydrom.Equipm.:Tender / Order Supply	15MAY08	30OCT08
AS008	Penstocks & Hydrom.Equipm.:Design	31OCT08	28JAN10
AS010	Penstocks & Hydrom.Equipm.:Manufactoring	23FEB09	27DEC11
AS015	Penstocks & Hydrom.Equipm.:Transport	01JUL09	16AUG12
DM030	Penstock & RCC Dam:Mid.Outlets Assembling	02OCT09	13MAR12
SR015	Gate Spillway:Hydro/Electrom.Equipm.Assembl.	05JUN12	06JUN13



Early Bar
Progress Bar
Critical Activity

GBDC

Salini Costruttori S.p.A

Gibe III Hydroelectric Project

Work Programme

Sheet 2 of 2

Date	Revision	Checked	Approved
18APR08	RCC Dam : Change due to Adoption of RCC Dam	F.G.	C.F.C.

3 DOWNSTREAM ENVIRONMENT

3.1 Physical Environment

The lower Omo River articulates along the East African rift valley system, within the rift Valley Terrain. Its main physiography is outlined as follows:

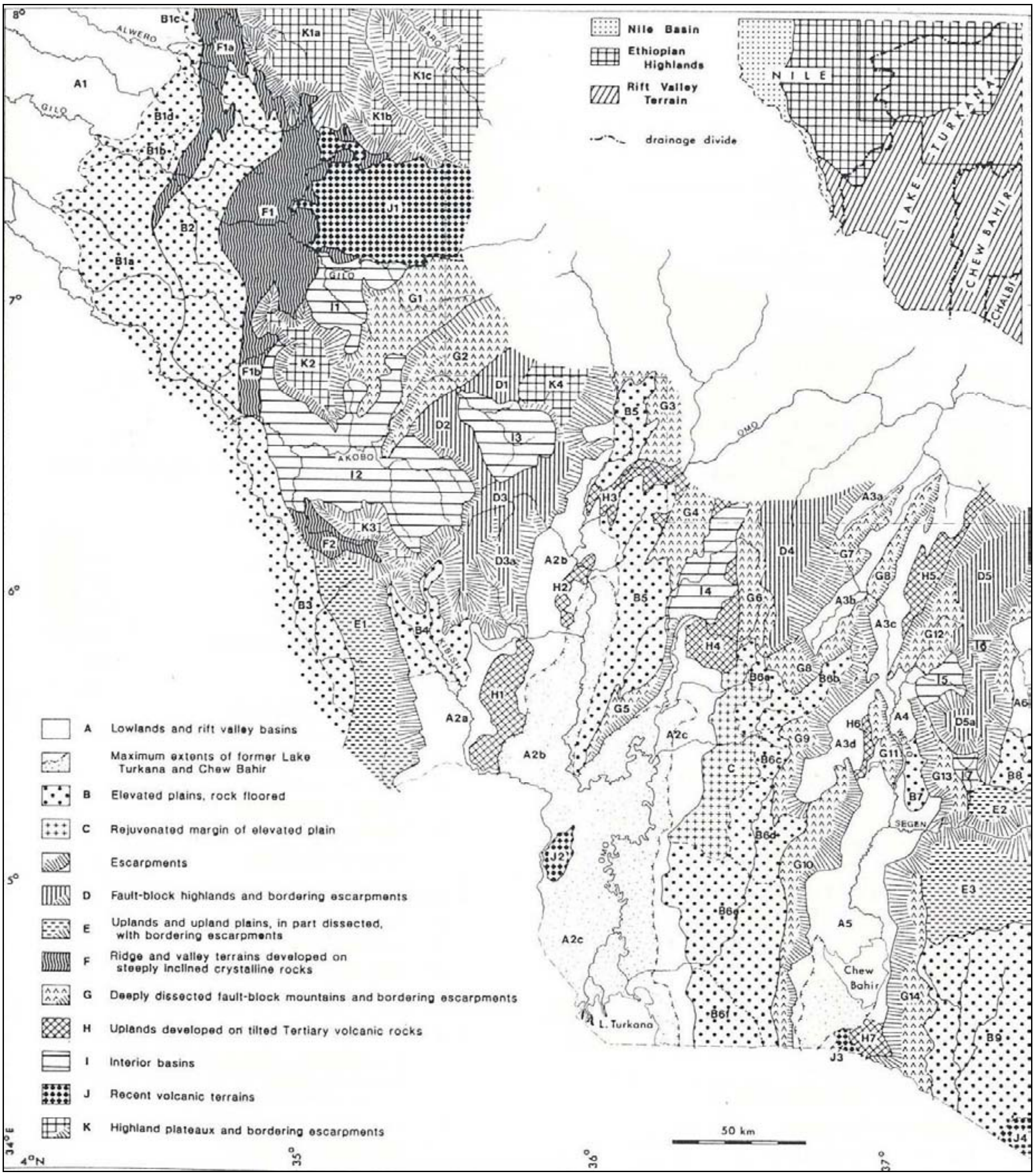


Figure 3.1: Omo River Basin and detailed Lower Omo River Basin physiography

Three major drainages systems are hereby included, namely the Nile, Lake Turkana and the Chew Bahir (Lake Stephanie) drainage system.

The Omo River as the main tributary to the Lake Turkana system, drains southward a large catchment area (73,500 km^2) from the central Ethiopian plateau. It is joined by the Deme, Zage, Mansa, Zinga, Denchiya, Woshi, Aku, Muri and Meki (Neri) tributaries downstream the Gibe-3 proposed dam site.

It enters Lake Turkana from the north, while the Kibbish enters into Lake Turkana from the northeast via the Sanderson gulf. The Chew Bahir is fed by the Segen River, which drains Lake Chamo, in the east of the map area, and by its main tributary, the Weyto.

Low divides south of Chew Bahir separate this drainage from the Lake Turkana basin and also from another basin, the Chalbi Desert in northern Kenya, toward which flows the Bulal River in the extreme southwestern part of the area. Lake Turkana, at 375 m asl, is located in the lower part of the area.

Generally, the elevation of the basin decreases going from northeast to southwest. The gradually sloping surface has been greatly modified in two ways: 1) the Ethiopian Highlands have been dissected by the head-ward erosion caused by the streams draining water into the Nile, and 2) the Highlands are bordered by an erosion escarpment that is only locally fault-controlled.

On the other side, the topography of the Rift Valley Terrain in the central and south-eastern parts of the area is predominantly fault-controlled and modifications of the horst and graben originating from the late Tertiary rifting activity are observed.

The typical physiographic features of this region owe their origin mainly to the control effect enforced by the faults in association with rifting.

The branches of the Turkana system are principally bounded in the west by a steep escarpment (E1, D3a, G5) that has developed along sets of parallel faults causing a pronounced uplift to their west.

Their floors are repositories of Pliocene to Quaternary sediments, while the basement rises gradually eastward (and northward in the Kibish plain casa) turning into rock-floored elevated plains (B4, B5, B6) that form the western flanks of the intervening horst. These undergo active erosion.

The surface elevation of the horst blocks increases markedly to the east and gradually to the north while rising towards the steeply dissected mountain ranges and highlands.

The mid-Omo plain (A2b) and the adjacent Mursi basalt plain (B5) are interrupted by a central horst (H2, H3) and separated by another horst, the Hillibay range (H1). The Omo and Kibish plains are aligned with the latter.

The monotonous lower Omo plains (A2c) are broken only by a very young chain of volcanic cones and follow the Korhath range (J2). The lower Omo plains are bordered on the east by Precambrian basement rocks and in the southern portion near the Kenyan border by an Oligocene Miocene basalt formation.

A large fluviatile fan is still developing along the eastern escarpment south of Omorate town. Such fan, as well as the other two located further down the valley, originated in Lake Turkana when the water level was higher than at present.

The decrease of Lake Turkana water levels has also brought about imbalances in the Omo River that is presently eroding its riverbed. The river meanders that developed when the river was stable are rapidly and continuously diminishing. Dead meanders (Ox bows) are visible in part “C” of the river.

3.1.1 Geomorphology

For what concerns the area downstream the dam, the Omo river course has been divided, for easiness of analysis, into four distinct geomorphologic sections described below. Chainage described starts from the Gibe-3 dam, as per following Figure.

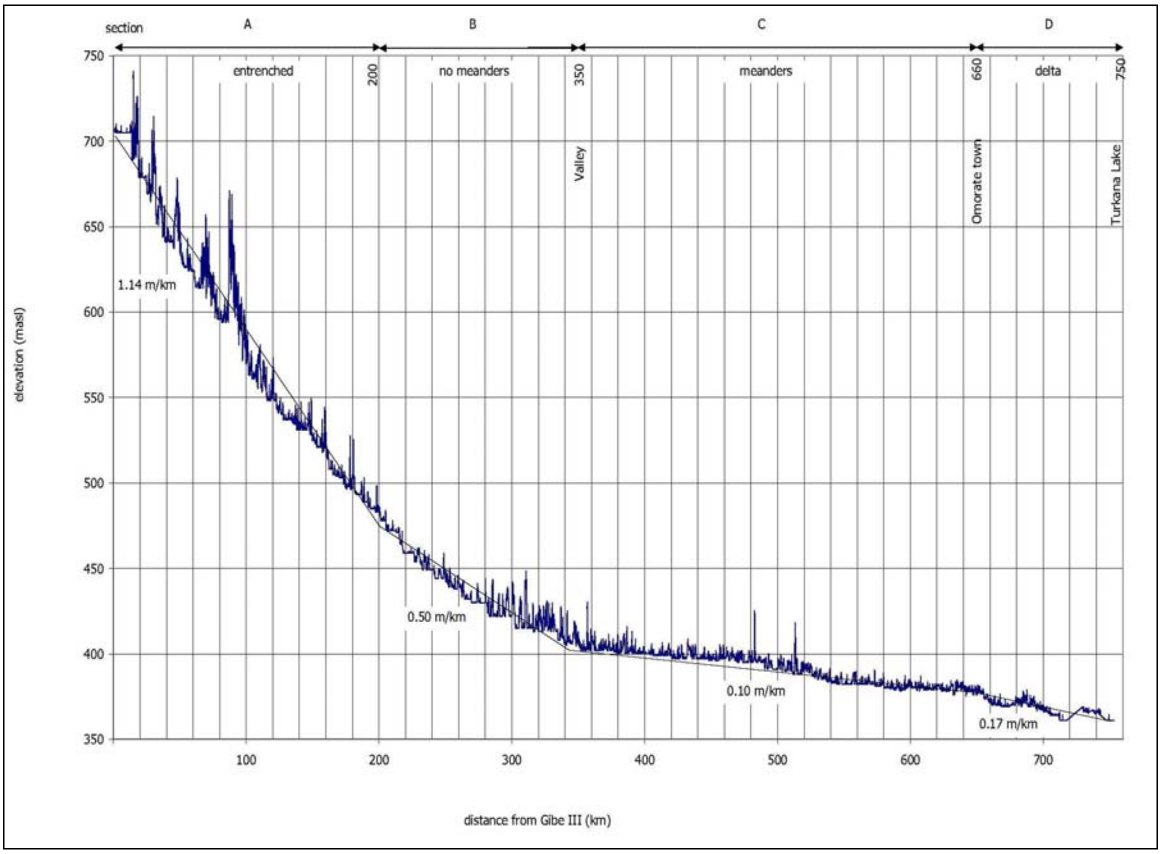


Figure 3.2: Omo River profile from Gibe III to Lake Turkana

A) ***Chainage 0-200. River slope 1.14 m/km*.** The first section commences from Gibe III dam and ends some 80 Km north of the right-bank tributary Woshi/Sherma. The river course develops consistently between the Jimma basalt Fm rocks. Within this area the river does not create alluvial areas suitable for farming.

The longitudinal slope of the river (1.15 m/km) as well as its transversal sections show that the water speed is sufficiently high to prevent deposition of sediments.

We observe that in this part there are no cultivations directly influenced by the Omo River.

B) ***Chainage 200-350. River slope 0.50 m/km*.** This second section ends in correspondence of the Nyalibong range' most southern point, where the river strongly bends towards east.

This section of the river flows through Lake Turkana's ancient alluvium where the lithological group outcropping therein is formed by a clayey layer termed Kibbish formation, deposited above the Omo river recent alluvium.

Whilst eroding Lake Turkana alluvium and its ancient deposits, the river runs through a deep incision between over 10m-deep vertical walls. The valley is generally formed by an approximately 20m high ancient terracing whose width ranges from 2 to 1 km.

Beyond the river, the left bank rises at a minimum inclination (0.6°) while on the right side the plains harbour the Omo National Park area.

A limited degree of recession agriculture takes place in this part of the river confined to riverbanks. Such farming zones are approximately 30m wide, with their lengths varying from a few dozen to a few hundred meters. The riverbank also represents a convenient drinking water point for cattle.

This part of the river is mainly inhabited by the Mursi tribe, together with the Bodi on the left and the Tischana, Chal and Nyangatom tribes on the right. These population groups travel from their villages to zones located even 30km away from the river at the end of the rainy season in order to crop the small plots of land made cultivable by the river.

C) *Chainage 350-660. River slope 0.10 m/km*. This third section commences from the Nyabong range and reaches the town of Omorate.

This part of the river is characterised by several meanders with its course developing through recent fluvial alluvium hanging over Lake Turkana clayey riverbed.

The meanders are very frequent and their twisting and turning often inverts the predominating direction of the river. In some instances old meanders were cut off by the river adopting a higher slope through a short-cut, now providing typical ox-bow off-stream seasonal reservoirs.

Recession agriculture is particularly developed on this part of the river due to the many meanders of which in particular the inner part is cultivated where the water speed during floods is lower thus permitting the deposition of fine materials.

The bank-recession cultivated plots are usually shared between families according to a well-established system of fencing and allocation.

Abundant narrow strips of riverine forests also characterise such meanders.

The river flows in an 8-m minimum deep incision when not perched, reaching a depth of some 15m when pensile. The surrounding valley is generally flat being at some points lower than the river level. This zone is highly inhabited with the presence of many water points and cattle at pasture.

Lake Dipa is located within this section. In the high-flow season, the lake is fed by the Omo River through a natural intake placed in the proximity of the Murule Game Reserve.

The relief map referring to this part of the river indicates the presence of the Hamer, Banner and Kara populations on the left, while Nyangatom and Dasenech inhabit the right side.

D) *Chainage 660-750. River slope 0.17m/km*. the fourth and final section is formed by the Omo river delta entering into Lake Turkana. The river divides into several arms forming 31 densely populated and cultivated islands.

A central marshy area, where expanses of water are often found, usually comprises such islands. The marshes appear being surrounded by a strip of land used for grazing while the river arm areas are being utilised for recession agriculture.

Permanent farmlands characterise the eastern part of the river delta. The water level at Omorate still fluctuates within a 10-m deep river bed according to the seasonal flow, thence fluctuation slowly decreases towards Lake Turkana.

The ending part of the delta is made up of marshes. Towards the north, the land is used for grazing, especially on the left part. Fields are cultivated in the entire area of the delta, which is well supplied with water originating from the river, which keeps the water table very close to the surface.

3.1.2 Climate

Ethiopia experiences two rainy seasons as a result of the annual movement of the ITCZ (Inter-Tropical Convergence Zone) low-pressure system. This passes south through the country from March to May, bringing the main rains, and north again from September to November, bringing the “short” rains.

Annual rainfall is low in the Omo valley downstream of the proposed dam site, compared with the upstream catchment, and is also unreliable, resulting in frequent droughts.

Particularly in the lower part of the study area annual rainfall rapidly decreases from 700-800 mm (study area’s average) to less than 300 mm.

Rainfall totals some 400 mm/year in Hailoo-Salamago, around 300 mm in Kara Dus, less than 300 mm in Nyangatom and Omorate, and some 100-200 mm in the delta, possibly nil in recurrent years of drought.

The amount of rain received annually is thus generally insufficient to grow rainfed crops in the lower portion of the basin and people in that area depend on river flooding the land to provide enough soil moisture for subsistence recession cropping.

Temperature increases and rainfall decreases as one descends southwards through the lowland plains of the Omo River, to an altitude as low as 300 m asl near Lake Turkana.

In the delta area, where most of the recession farming is found, the average daily temperatures are around 30°C, with maximum values reaching over 40°C in summer.

3.1.3 Geology

This section describes geology and the geological structure of the Lower Omo River Valley, particularly in connection with water resources. The lower Omo Basin geology can be divided into two large groups:

Rock formations crowning the lower Omo basin

Sediments forming the lower Omo basin

3.1.3.1 Rock formations crowning the lower Omo basin

Crystalline basement

“Hammar Domain” rocks form the crystalline basement. The domain in the study area underlies the lower part of eastern Omo river area and the northern part of Lake Turkana.

This area contains two major rock groups: a complex of older gneiss and granulite, which is highly deformed, re-crystallized and partly migmatized, as well as a suite of younger plutonic rock not necessarily related to the other and far less or not deformed / re-crystallized.

The geological structure is oriented NNW-SSE and develops in subsequent plates whose width varies from 6 to 12km. Subsequently, the structure bends and develops northwards encircling the plutonic masses.

The principal faults are oriented ENE-WSW. Traces of faults and fractures are also observed in the sediments that fill the Omo River valley.

Metamorphic rocks (Precambrian**)**

Peq,f-Predominantly leucocratic biotite-quartz-feldspar gneiss;
Peb,h-Undivided gneiss; predominantly biotite and hornblende
Gneiss, partly migmatic with minor metasedimentary gneiss, quartz-feldspatic gneiss, amphibolite and granitoid orthogneiss;

Peg,b-Metasedimentary gneiss: layered biotite-quartz-feldspar gneisses, locally with muscovite, garnet, sillimanite; minor interlayered amphibolite, quartzose, pyritic, graphitic, and calc-silicate gneisses and marble;

Peh,a-Layered mafic gneiss and amphibolite;

Plutonic rocks (Precambrian**)**

Pg2-Late tectonics granite.

Pg1-Syntectonic granite, granodiorite, granitoid gneiss.

Pre/Post-rift sediments/volcanic

The Pre/post-rift sediments/volcanic are characterised by four principal formations: *Main volcanic sequences*, basalt, rhyolite, trachyte, tuff, ignimbrite (Eocene, Oligocene), Omo *group* (Mursi formation basalt), Shungura formation (Pliocene), *Nakwa formation* basalt (quaternary).

The Main formation sequence rims the western side of the lower and middle Omo valley reaching the Jbai range and the inner zone of the eastern part, to the east of the Mursi plain, while the Nakwa formation generates the Korath ranger located in the lower part of the western Omo, and the Mursi formation covers the eastern part of the mid-Omo valley (Mursi plain).

Pv-Pre rift main volcanic sequences, basalt, rhyolite, trachyte, tuff, ignimbrite. (Eocene-Oligocene)

The undivided part of the pre-rift volcanic succession is separated almost everywhere from the crystalline basement by the basal residual sandstone. Basalt dominates the lower part of most sections, followed by a thick unit of salic rocks. However, salic flows and breccias lie directly on the sandstone in some places. The thickest salic succession lies astride a north-north-east axis along the mid-Omo plain trend.

The main faulting trend is oriented NNE-SSW according to the rift valley orientation.

Npom-Post rift Omo group-Mursi fm. (Pliocene)

The Mursi Fm is divided into two units, the lower being sedimentary and the upper one formed by flood basalt. The well-studied lower-sedimentary unit, divided into three members, is exposed at the west side of the southern part of the Nyalibong range.

It lies unconformably on west-tilted pre-rift rhyolite and is composed of some 150m of clays, silts and sand with subordinate tuff and pebble beds. These sediments are conformably overlain by flood basalts having a total thickness probably less than 100m.

The Mursi basalt underlies much, if not all, of the cover of the middle Omo plains, (Mursi people plains) and its extension could continue southward beyond the Nyalibong ridge.

Nqos-The Shungura formation is exposed for about 60m along the west side of the Omo river north of Lake Turkana, and includes 760 m of brown, grey, and buff clays, silts, sand, gravel, tuffs, marls and freshwater limestone. These sediments are tilted gently to the west and are overlain by the shallow unconformity of the Kibbish formation. The faults develop both parallel and oblique to the north with respect to the axis of tilting and have an offset bedding of several metres locally. The sedimentation records fluctuating fluvial and lacustrine cycles.

QHn-Nakwa Formation (quaternary) Mont Nakwa is located in the middle of a chain of very recent and well-preserved volcanic cones known as the Korath range which lies 55Km north of the Turkana Lake. These cones stand 400m above the monotonous surrounding plains that are effusive events for volcanic rocks with basic alkaline affinity. The main lavas are basanites with minor thephirite.

The cones are aligned north northeasterly, i.e. the same trend as the Turkana rift and many of the prominent faults in the region.

3.1.3.2 Sediments composing the lower Omo basin

Local lacustrine, fluvial and fluvio-lacustrine sediments divide into five formations which all belong to the Pleistocene Holocene.

These include Kibish formation; Undivided alluvial, fluviatile, lacustrine sediments; Fluviatile sand and silt; Lacustrine silt and clay; Alluvium.

OK-Kibish Formation. A sequence of horizontal sediments, related to the major fluctuations in the ancestral Lake Turkana level, lies unconformably above the various formations of the Omo Group while dissected, and in its turn overlain, by the late Holocene deposits.

The sequence is termed “Kibish” Formation and is well exposed where the Omo river and its ephemeral side tributaries have cut through the otherwise flat and unravelling plain that apparently marks its top surface.

It comprises four members with a measured thickness of 120m, while a slightly greater thickness is inferred**.**

The lowest unit, *Member I*, is at least 31m thick; it has gravelly sand at the base, which is followed by a partly laminated and ripple-marked succession of clay, silt and sand, and contains reworked tuff close to the base. Its top is marked by a soil horizon.

Member II, 22m thick, is composed prevailingly by massive silts, deposits on the basal tuff blanketed and dissected surface of member I.

Member III, 46m thick, records two Lake Turkana advance and retreat cycles and is separated by a prominent 3m thick subaqueous tuff bed.

Clays, silts and sands, form its sediments as well as shell beds associated with the second cycle. Another erosional interval separating Members III and IV is marked by a soil horizon and the subsequent dissection.

Member IV is divided into two units: Unit IVa comprises 13,5 m of sand, silts and clays with a gravelly base while IVb is formed by 8 m of sands and silts with minor tuff. The two sub-members represent the transgression of Lake Turkana, separated by a regression close to the present lake level.

Q-Undivided alluvial, fluviatile, and lacustrine sediments. In the northern part of the mid-Omo Plain, undivided Quaternary alluvium is located adjacent to the northern limit of the Kibish Formation, as shown on the map that partially overlies the Kibish Fm and is therefore younger than the Kibish sediments. This may also be partially equivalent in age and represents the terrestrial fluviatile and alluvial facies.

Ql-Lacustrine and Qr-Deltaic sediments in the northern lower Omo basin were interpreted as belonging to the Kibish Fm. They are treated in the following section. The interpretation of the surface geomorphic features suggests that it may be younger. At its highest level, about 80m above the present level, the ancestral Lake Turkana was able to overflow through a low divide southwest of the Kibish settlement into the Logitipi swamp in north-western Kenya, and thence to the Nile drainage system.

The overflow levels were last reached at the end of the Kibish member IVb time of deposition formation about 3250 years ago.

Since then, the Lake has retreated and risen again perhaps by as much as 40m, which was sufficient to flood northward along the eastern side of the Turkana depression into the Usno plains (A2c).

The lacustrine sediments originating from this stage are now exposed on the banks of the Omo river south of the Usno river confluence.

Thence, although interpreted as Holocene, their extrapolated extent is shown in the geological map as Unit Ql rather than QHl in order to distinguish them from the far more recent alluvial fan (Qha) and fluviatile (QHr) deposits in the region.

The successive formations bear witness to the complicated system of tributaries during the numerous Lake Turkana ingressions and recessions.

3.1.3.3 Hydrogeology

Basement rocks with low permeability are found in the catchment area *on the left bank* of the Omo river. In this area the faults system is orthogonal with respect to the river. Here we find:

Metamorphic rocks **(Precambrian)**

Peq,f-Predominantly leucocratic biotite-quartz-feldspar gneiss.

Peb,h-Undivided gneiss; predominantly biotite and hornblende.

Gneiss, partly magmatic with minor metasedimentary gneiss, quartz-feldspatic gneiss, amphibolite and granitoid orthogneiss.

Peg,b-Metasedimentary gneiss: layered biotite-quartz-feldspar gneisses, locally with muscovite, garnet, sillimanite; minor interlayered amphibolite, quartzose, pyritic, graphitic, and calc-silicate gneisses and marble.

Peh,a-Layered mafic gneiss and amphibolite.

Plutonic rocks **(Precambrian)**

Pg2-Late tectonics granite.

Pg1-Syntectonic granite, granodiorite, granitoid gneiss.

On the river *right bank* the rocks are more permeable and absorb large quantities of rain water. These include:

Pv-Pre rift main volcanic sequences, basalt, rhyolite, trachyte, tuff, ignimbrite.

The quantity of water absorbed by these rocks highly reduces the surface flow of water.

The underground water resources are dispersed in the infinitesimal voids in between the rocks.

In the Lower Omo area there are *primary* permeability rocks with intrinsic porosity and *secondary* permeability depending on the rock faulting. *Primary* permeability rocks are composed of the sediments forming the Lower Omo basin while *secondary* permeability rocks encircle the Lower Omo basin.

Primary permeability rocks include:

Q-Undivided alluvial, fluviatile, and lacustrine sediments.

Drilled wells could be realized within this formation although with reduced productivity during the dry season.

OK-Kibish Formation (ancestral sediments of Lake Turkana). A sequence of horizontal sediments, related to the major fluctuations in the ancestral Lake Turkana level.

The most ancient member of this formation is composed of sands and conglomerates (highly permeable), while the above-lying formations are mainly impermeable. This kind of rock geometry produces a confined water-table fed by the nearby basin and only in small part by the Omo river.

The realization of drilled wells in this formation could provide considerable supplies of water in all seasons.

Secondary permeability rocks include Metamorphic rocks **(**Precambrian**)** and Plutonic rocks (Precambrian**);**

These rocks are located in the Eastern part of the Omo basin and are characterised by low permeability. However, where two or more faults cross, such rocks crumble and turn into highly permeable 20-30m high layers sandy soil; In these cases, reasonable levels of production could be obtained by servicing hand-dug wells.

Pv-Pre rift main volcanic sequences (Eocene-Oligocene)

This mainly volcanic sequence is located in the north and west of the basin. These rocks are permeable due both to their porosity and structure. The water-tables are located at an approximate depth of 100m and are nearly always confined and often formed by hydrothermal residuals having significant temperature and pressure.

In this case, the search for water requires the use of technical devices and relevant financial means.

3.1.4 Water resources

3.1.4.1 Description of the watershed

The Omo River (termed Gibe in its upper reach) originates from the Ethiopian Plateau (9° N, 37° E) at an elevation of about 2200 m a.s.l.

Although there are several tributaries joining the main course from different headings the general direction of the flow of the Omo River is southwards, towards the Lake Turkana.

The northern part of the catchment receives tributaries from NE (draining largely cultivated areas with relevant erosional process) with Tunjo and Gilgel Gibe affluents coming from SW (draining cultivated lands where soils are, however, quite permeable).

Further downstream the Gojeb river joins the Omo from W (draining lands mainly covered by wooden shrubland).

The total catchment area at the Gibe III site (6°51’ N, 37°18’ E) is 34150 km^2.

Average rainfall in the Gibe III watershed ranges from about 1900 mm/year (northern and western part) to about 1200 mm/year (lower and eastern part).

Downstream of the dam the Omo river flows “entrenched” for about 200 km and through an “incision”, generally more than 10 m deep, for about 150 km.

Along the reach heading W several small though perennial affluents (Sana, Deme, Zage, Irgene) join the river draining the highlands from E/S. Average rainfall in these sub-basins ranges from about 1500 mm/year (south) to 1000 mm/year (east).

Along the reach heading SW the Zinga and Mansa tributaries (smaller) and the Denchiya and Toshi/Sherma rivers (larger) join the Omo after draining the upper highlands (mainly covered with a vegetation of wooden shrubland). The average rainfall ranges from about 1600 mm (north) to 900 mm (south).

About 80 km downstream the longitudinal slope of the riverbed flattens and gorge opens as the river crosses a hilly and semi-arid landscape.

The river changes in characters with a meandering river channel ending at the river delta area. In this stretch the river is clearly in an evolutionary process, probably related also to the "shrinking" of the Turkana lake, where abandoned meanders and upcoming ones are clearly visible.

Along this stretch the Aku and particularly the Maiki, tapering streams with perennial tributaries, drain the highlands along the Omo basin boundaries.

Average rainfall in this area ranges from about 1500 mm/year (north-west) to 500 mm/year (south).

The Omo River then flows south across the arid plains and the Delta for some 100 kms.

The total catchment of the Omo at the Lake Turkana is about 73500 km^2.

The average rainfall within the whole Omo River watershed varies from 1900 mm/year (north-west) to less than 300 mm/year (south).

The figures included in the following pages illustrate the river system and the hysoietal mapping in the watershed.

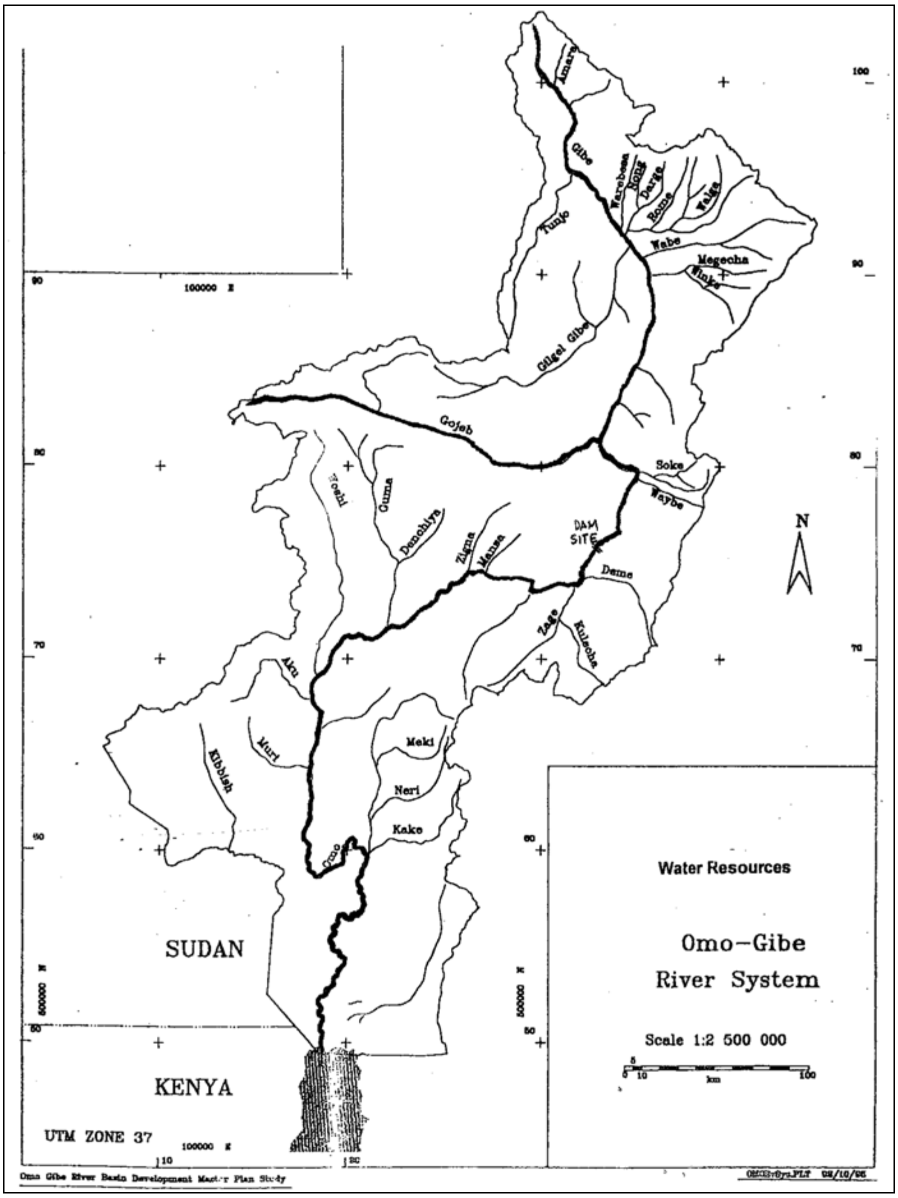


Figure 3.3: Omo-Gibe River Basin

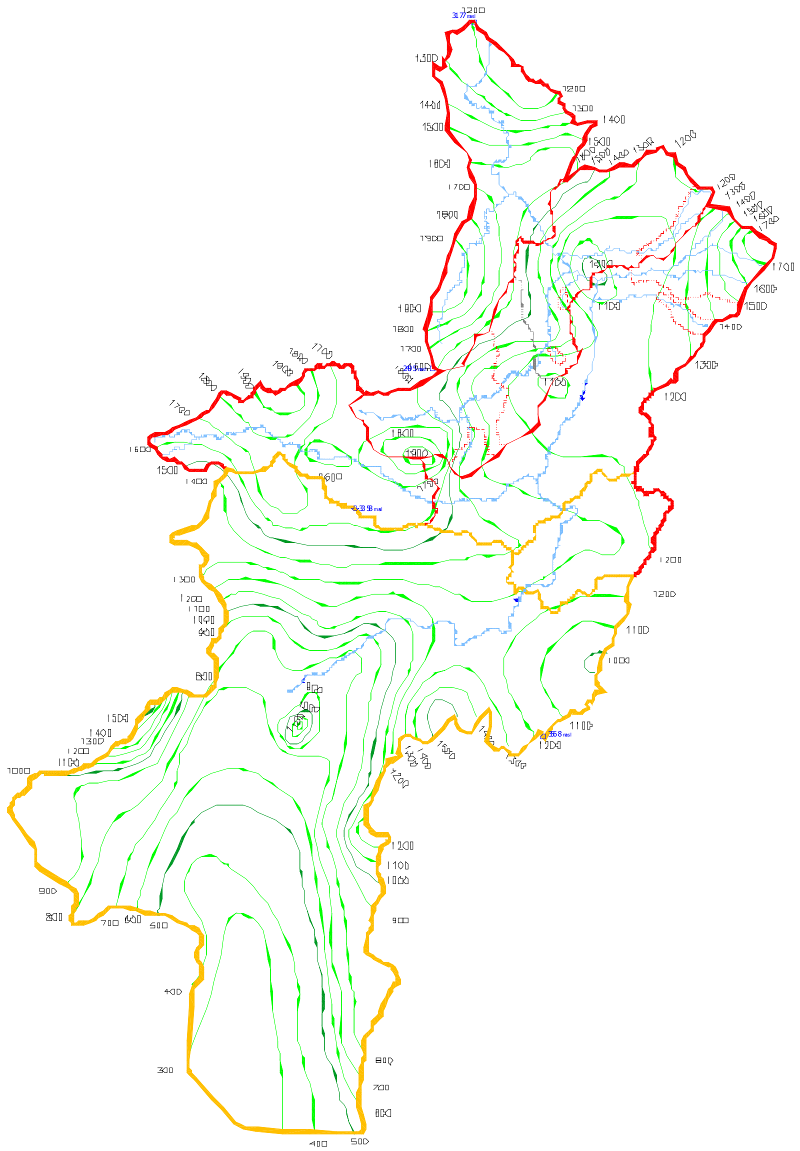


Figure 3.4: Isohyetal map Omo- River Basin Master Plan

The rainfall pattern substantially varies within the watershed.

In the northern part of the basin precipitations show a marked unimodal distribution with a pronounced peak in August and a long dry season from November to March.

In the central part a trapezoidal distribution can be observed with a quite constant rainfall from May to September and a less pronounced dry season from December to February.

In the southern part a marked bimodal pattern is visible with a higher peak in April and a secondary peak in October.

The following graph illustrates the average monthly rainfall at three meteorological stations (Wolkite, Bonga and Jinka) during a 40 years period (1955-1994).

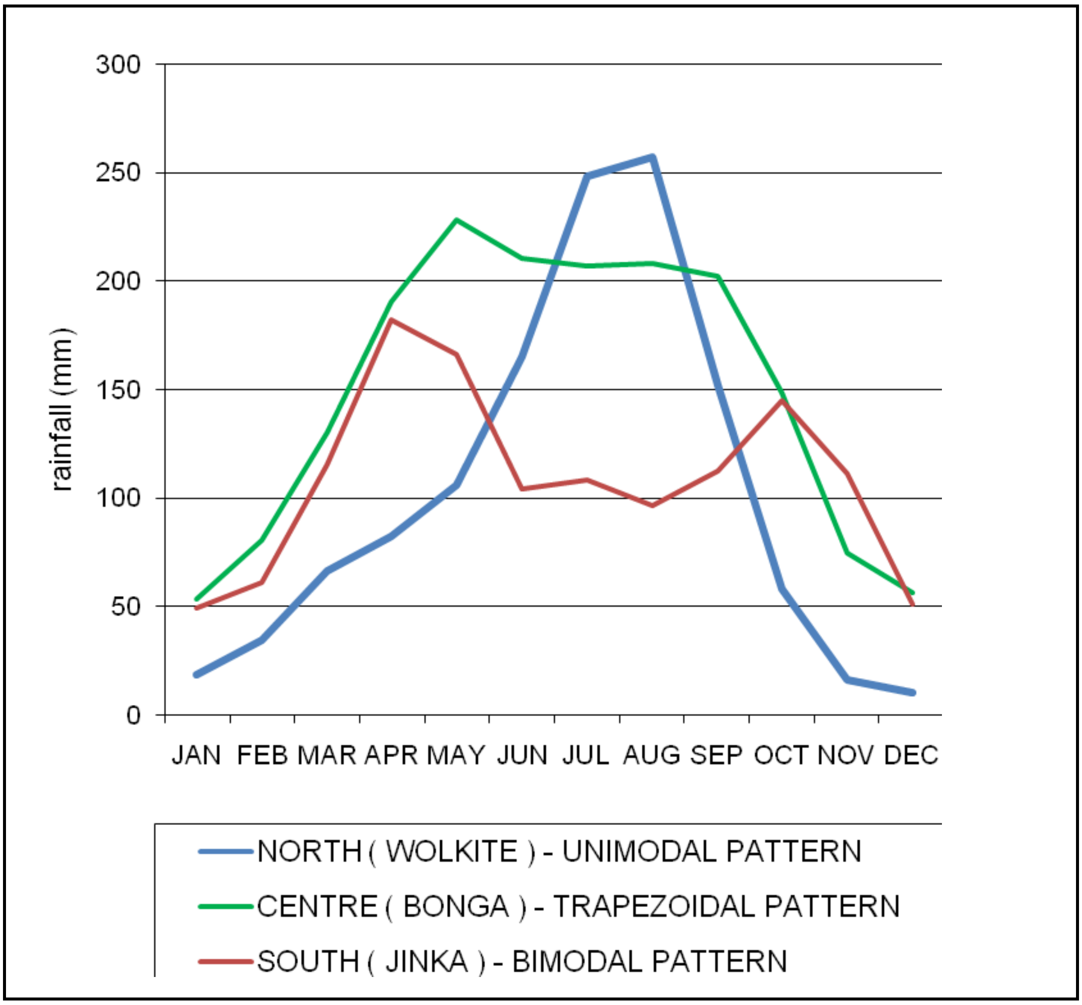


Figure 3.5: Rainfall patterns variation within the watershed

The variation of the rainfall pattern in the watershed contributes to the natural "regularization" of the Omo river flows downstream of the Gibe III site.

3.1.4.2 Omo river flows

The Omo river flows at the Gibe III site have been assessed by the analysis of a robust and long data series (about 40 years) of hydrometrical (and pluviometrical) records, resulting in a mean runoff of 438 m^3/sec.

Available long-term records of the mean monthly flows have been integrated and processed in order to generate a 38 years flow sequence (1964-2001) as shown in the following table.

Average monthly flows, shown in the figure below, vary from a minimum of 60 m^3/sec (March) to a maximum of about 1520 m^3/sec (August).

Table 3.1: Gibe III inflows sequence (1964-2001)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
	m^3/s												
1964	91.8	84.9	53.4	81.0	167.0	350.3	1'105.3	1'604.2	1'339.2	820.9	221.9	360.4	523.4
1965	82.2	63.8	43.5	113.3	95.7	319.6	869.3	1'540.0	898.4	719.1	266.8	159.7	430.9
1966	66.8	77.9	79.2	138.4	95.8	249.0	914.5	1'439.5	1'139.0	388.9	150.8	75.9	401.3
1967	45.2	39.2	66.9	71.9	121.9	322.9	823.4	1'314.8	1'076.3	787.2	302.8	144.6	426.4
1968	78.1	81.7	51.7	86.5	112.4	298.5	909.2	1'441.6	934.1	456.3	151.5	100.3	391.8
1969	63.5	84.1	126.0	83.0	128.2	335.0	960.9	1'408.3	1'014.4	523.1	135.5	71.8	411.1
1970	58.3	52.5	73.6	95.5	111.1	308.8	1'016.0	1'824.6	1'191.4	639.5	175.7	87.9	469.6
1971	54.9	41.5	36.6	51.7	104.0	271.1	940.3	1'526.9	1'147.7	629.9	253.2	98.2	429.7
1972	59.7	52.9	43.5	82.6	121.0	231.8	914.4	1'210.0	784.2	257.6	152.0	66.3	331.3
1973	48.9	35.8	25.2	58.5	152.0	300.4	869.9	1'523.6	1'188.3	567.6	143.4	61.0	414.5
1974	40.8	41.0	46.6	56.9	97.8	273.4	670.7	1'174.5	836.4	508.3	153.0	57.5	329.7
1975	43.1	49.6	37.4	60.0	75.6	278.1	933.6	1'719.9	1'418.9	668.2	168.4	86.0	461.6
1976	52.3	47.6	46.4	49.4	136.6	346.8	942.6	1'226.2	761.6	270.6	152.8	60.3	341.1
1977	58.0	134.7	48.7	64.3	68.1	252.6	1'148.3	1'638.3	1'367.8	880.7	280.6	123.3	505.5
1978	66.4	54.2	52.8	68.0	224.4	465.3	1'257.9	1'786.8	1'062.9	700.9	194.6	122.1	504.7
1979	105.0	108.2	83.2	103.1	122.9	267.2	781.8	1'109.6	703.8	369.6	162.3	223.2	345.0
1980	275.0	113.2	85.4	94.8	162.6	344.6	791.0	1'166.8	676.2	303.6	144.0	80.5	353.1
1981	60.6	60.3	64.0	68.0	86.7	176.9	608.2	1'411.1	991.6	456.9	104.4	56.0	345.4
1982	47.6	246.6	36.5	54.8	83.5	225.3	575.3	1'142.1	776.8	572.0	168.4	105.8	336.2
1983	52.6	84.5	47.2	62.5	117.3	219.1	598.2	1'489.4	1'256.6	686.5	219.9	106.6	411.7
1984	291.7	47.3	39.3	55.4	77.9	266.6	797.6	1'151.3	848.1	199.8	87.3	60.1	326.9
1985	37.8	33.4	30.9	51.0	121.1	245.1	727.5	1'424.2	1'045.8	318.9	108.7	64.2	350.7
1986	43.0	47.2	56.9	78.9	91.9	320.8	795.4	948.3	845.2	303.3	84.0	53.8	305.7
1987	31.9	30.5	51.4	92.4	92.6	221.6	528.0	819.4	581.3	268.2	114.0	51.4	240.2
1988	54.6	56.1	46.0	57.2	83.1	219.7	1'492.9	2'360.9	1'589.4	1'219.8	409.2	207.0	649.6
1989	70.9	52.2	44.4	108.9	85.2	185.9	717.0	1'138.8	937.2	409.4	118.9	118.5	332.3
1990	64.7	64.6	73.3	88.6	101.9	319.9	840.2	1'527.1	1'126.9	558.2	179.6	117.6	421.9
1991	81.6	75.3	74.8	107.6	252.8	576.5	1'242.6	1'375.4	682.0	302.6	122.2	91.0	415.4
1992	49.7	62.1	48.0	76.3	123.9	256.4	735.3	1'464.7	1'522.5	943.2	436.0	132.7	487.6
1993	102.5	108.3	59.0	141.1	278.5	513.5	1'162.2	1'729.3	1'299.9	576.1	247.2	144.5	530.2
1994	83.5	71.5	64.3	89.8	179.3	426.5	1'214.5	2'159.6	1'317.9	301.8	159.4	110.7	514.9
1995	71.9	61.3	58.5	92.0	169.3	339.2	686.9	1'521.0	766.6	419.9	142.2	140.7	372.5
1996	76.0	94.9	151.5	176.8	327.6	877.3	1'389.4	2'271.5	1'101.9	600.8	198.9	128.8	616.3
1997	94.8	82.8	66.9	135.5	180.9	525.3	919.4	1'328.7	793.8	762.6	713.0	322.0	493.8
1998	189.2	118.4	166.3	115.3	221.0	270.2	1'240.9	2'285.6	1'413.7	1'149.3	373.8	138.1	640.2
1999	75.6	53.9	48.3	58.8	158.2	344.1	1'027.6	1'724.2	811.1	891.4	261.9	85.3	461.7
2000	62.1	49.5	37.9	100.9	233.3	354.7	1'151.5	2'039.3	1'321.3	944.2	361.8	133.0	565.8
2001	38.9	34.5	53.2	108.8	207.9	681.3	1'509.8	2'140.2	1'635.3	811.2	420.6	96.4	644.8
Mean	78.2	71.0	61.0	86.3	141.3	336.3	942.4	1'529.1	1'058.0	583.9	216.9	116.9	438.2

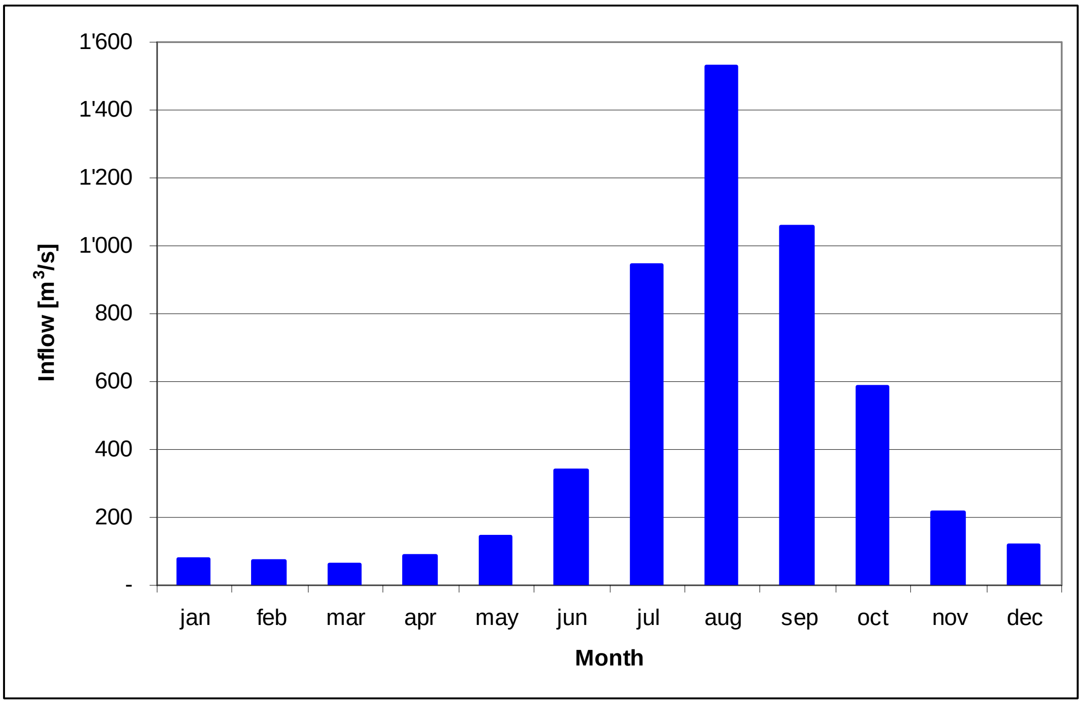
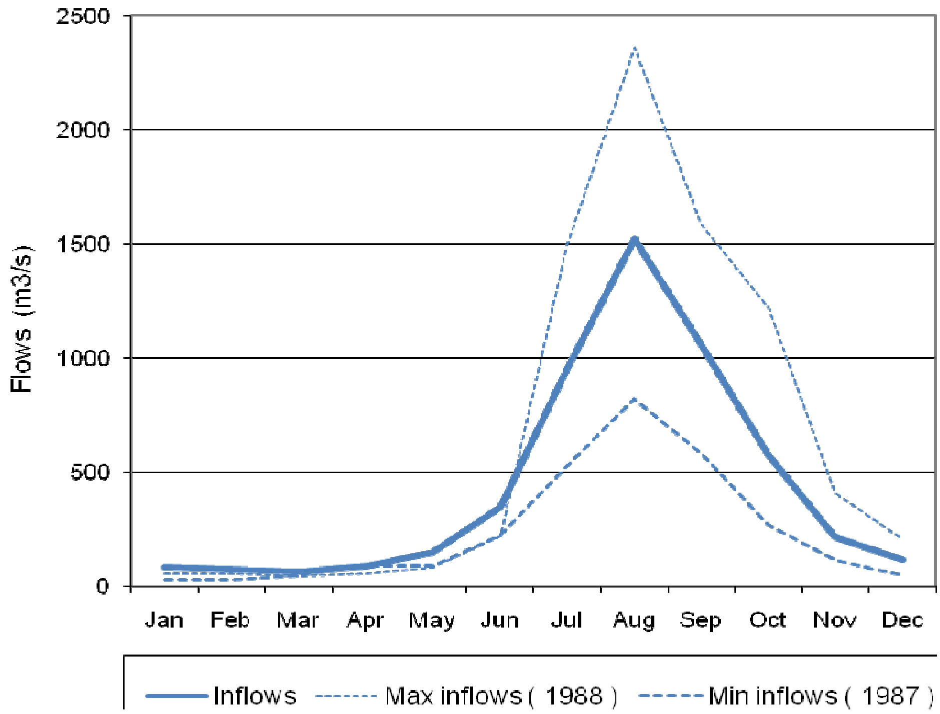


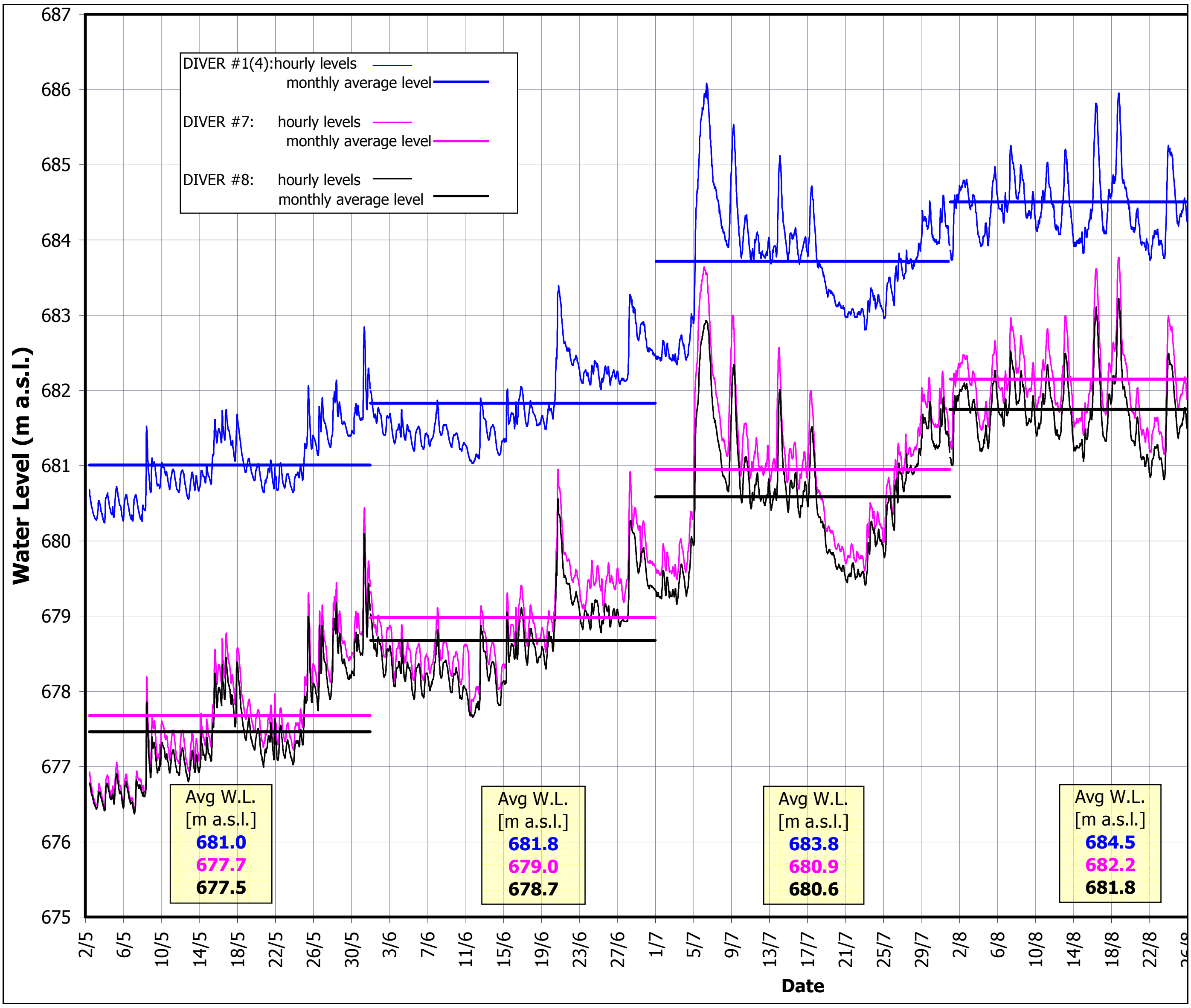
Figure 3.6: Gibe III Mean monthly flows

The multi-annual variations of the average flows are particularly relevant at the Gibe III site. The graph below compares the average monthly flows within the 38 years period with the driest year (1987) and the wettest year (1988) flows within the same period.

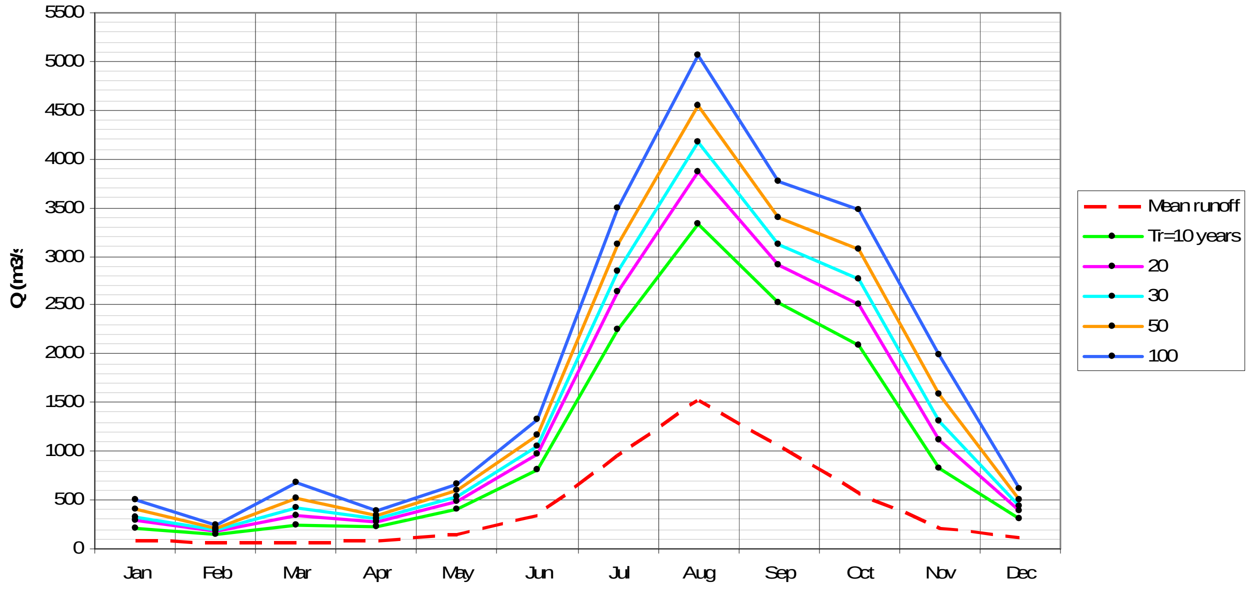


The graph below illustrates the sudden variations of the natural river flows as measured at three gauging stations nearby the Gibe III site during the wet season 2007 (May-August).

Due to the substantial reduction of the vegetation in the watershed caused by the land use, the variations of the river flows have become particularly rapid having, for example, discharges suddenly increased from 800 m^3/sec to 2300 m^3/sec in about 36 hours (5^{th} of July 2007).



The monthly peak floods of the Omo River, assessed by means of a regional flood frequency analysis, are recalled in the figure and table here below.



Q_{max} (m^3/s)	Tr=10 yrs	Tr=20 yrs	Tr=30 yrs	Tr=50 yrs	Tr=100 yrs
Jan	210	284	331	396	496
Feb	142	170	187	207	235
Mar	242	347	419	522	685
Apr	229	278	307	342	390
May	403	485	532	591	670
Jun	806	963	1054	1166	1319
Jul	2248	2631	2851	3126	3497
Aug	3336	3866	4170	4551	5065
Sep	2531	2911	3130	3403	3772
Oct	2082	2512	2759	3068	3484
Nov	824	1120	1315	1583	1994
Dec	303	387	439	508	609

The annual peak floods, evaluated by a similar regional statistical analysis on a slightly variated sample, with a 10-, 30- and 50-year return period provide, respectively, 4150, 5280 and 5800 m^3/s.

It can be recalled that these values are slightly higher than the corresponding peak values of the Month of August for classical statistical reasons (i.e. cumulating the 12 months probability of occurrence)

The mean annual flows of the Omo River at the Lake Turkana have been evaluated by means of an estimate of the mean flows in the residual basin Gibe III-Turkana.

Since no robust flow measurements series are available downstream Abelti/Gojeb the analysis has been carried out by elaborating rainfall data of the residual basin.

The mean annual rainfall, resulting from the isohyethal map above illustrated, for the residual basin downstream Gibe III site (denoted as “Residual 2” in the figure below) is 870 mm/year.

This value is far below the rainfall rate of the upper part of the basin, characterised by a wetter climate.

The table below shows the rainfall rates, the runoff coefficient and the mean flows for the main sub-catchments of the Omo basin.

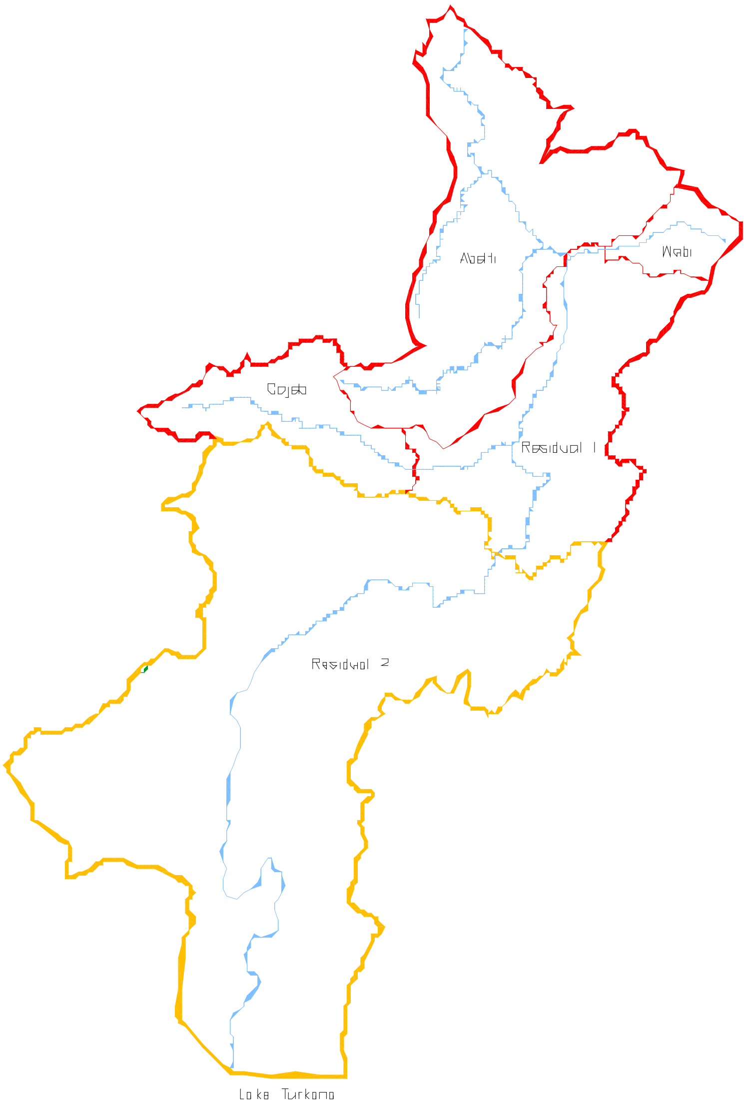


Figure 3.7: Main sub catchments of the Omo River

Table 3.2: Rainfall rates, runoff coefficients and flows for the main sub-catchments of the Omo River

	A	H	ϕ	Q
	(km^2)	(mm/year)		(m^3/s)
Gibe nr. Abelti	15853	1450	0.26	190.0
Wabi nr. Wolkite	1869	1430	0.39	33.0
Gojeb dam site	5186	1710	0.32	91.3
Residual 1	11251	1253	0.27	120.7
Dam site 5	34159	1424	0.28	435.0
Residual 2	43847	871	0.19	230.0
Lake Turkana	78006	1113	0.21	663.9

The estimation of the runoff coefficient for the Residual 2 catchment was carried out through the extrapolation of the values of ETP (Potential Evapo-transpiration) of the upstream catchments.

Table 3.3: Runoff coefficients for the main sub-catchments of the Omo River

	ETP (mm/year)	ϕ
Gibe nr. Abelti	1124	0.266
Wabi nr. Wolkite	1108	0.360
Gojeb dam site	1101	0.333
Residual 1	1215	0.266
Residual 2	1369	0.19

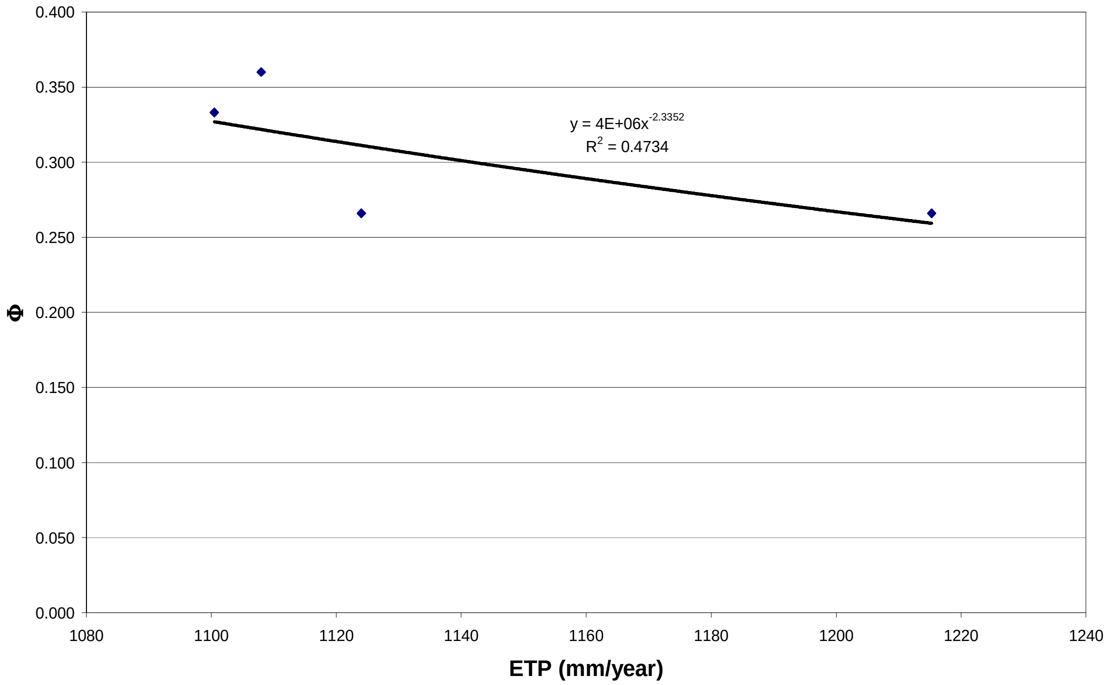


Figure 3.8: Extrapolation of the runoff coefficient according to ETP

For the Residual 2 catchment a reasonably conservative value of $\phi = 0.19$ was adopted, well below the values obtained for the upstream part of the basin.

This assumption leads to a mean flow at Lake Turkana of about 650 m^3/s.

The monthly variability of natural flows has been assumed to be the same as that reported in the Master Plan, shifted to the mean value of 650 m^3/s.

The figure below reports the adimensional variability of flows at Gibe III and Lake Turkana.

It can be seen that the monthly variability at Lake Turkana is smoother than the one at Gibe III. This is basically due to the variation of the rainfall pattern of the Gibe III basin and of the southern residual basin, which, however, produces proportionally less flows.

At Gibe III the summer peak is higher than at Lake Turkana (the coefficient is equal to 3.5, against the 2.5 at Lake Turkana). On the contrary the dry season flow is generally higher at Lake Turkana.

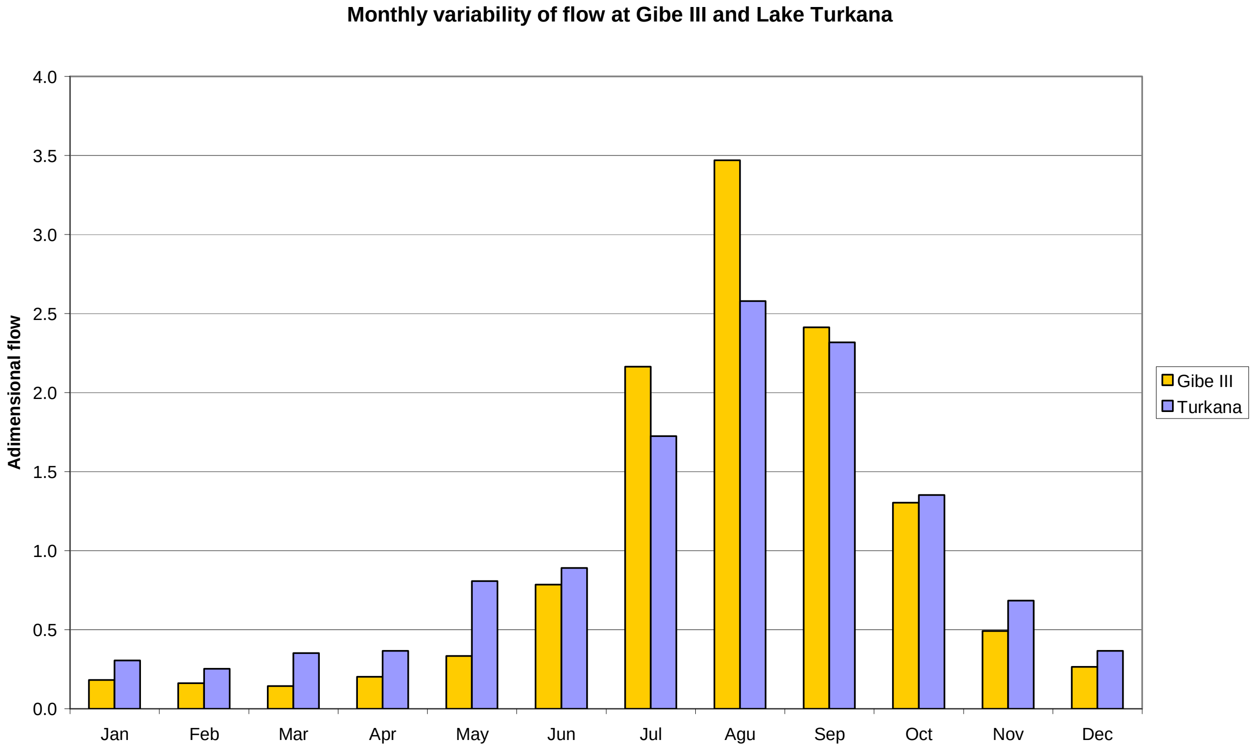


Figure 3.9: Adimensional flow at Gibe 3 and Lake Turkana

While the mean annual flow is higher at Lake Turkana, the summer peak is proportionally less evident and the August flow is not much higher than that at Gibe III. On the contrary high flow rates persist in September also due to the "ponding" effect of such a wide catchment.

The table below, illustrating the monthly variability of the flow rates at Lake Turkana, indicates that highest flows are to be found within the months of August / September.

Table 3.4: Monthly variability of runoff at Lake Turkana

	Average flows m^3/s
Jan	199
Feb	165
Mar	229
Apr	238
May	525
Jun	579
Jul	1122
Aug	1677
Sep	1506
Oct	879
Nov	444
Dec	238
Year	650

The contribution of the residual catchment is particularly relevant, if compared to the upstream basin, in May (slightly less than 400 m^3/sec) and in the dry season.

During these months a natural regulation of the Omo river flows at the Lake Turkana derives from the contributions of the residual basin Gibe III - Turkana.

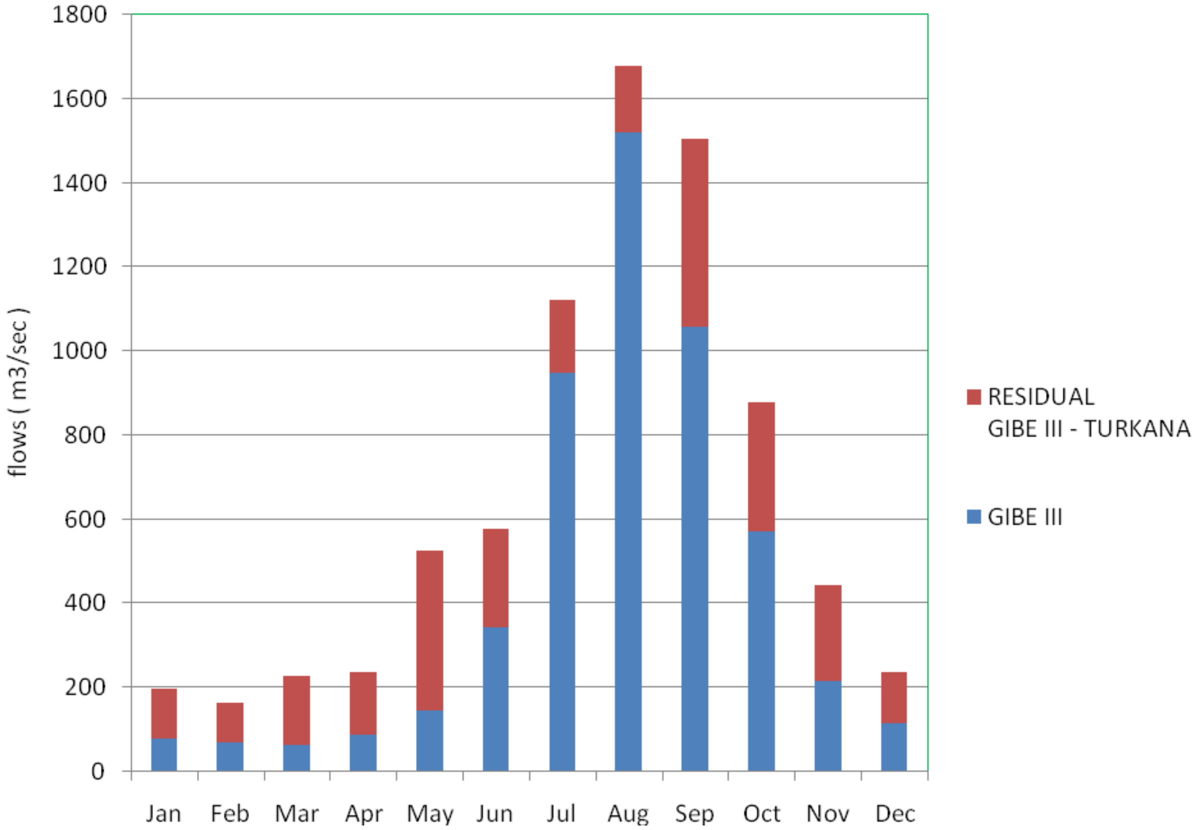


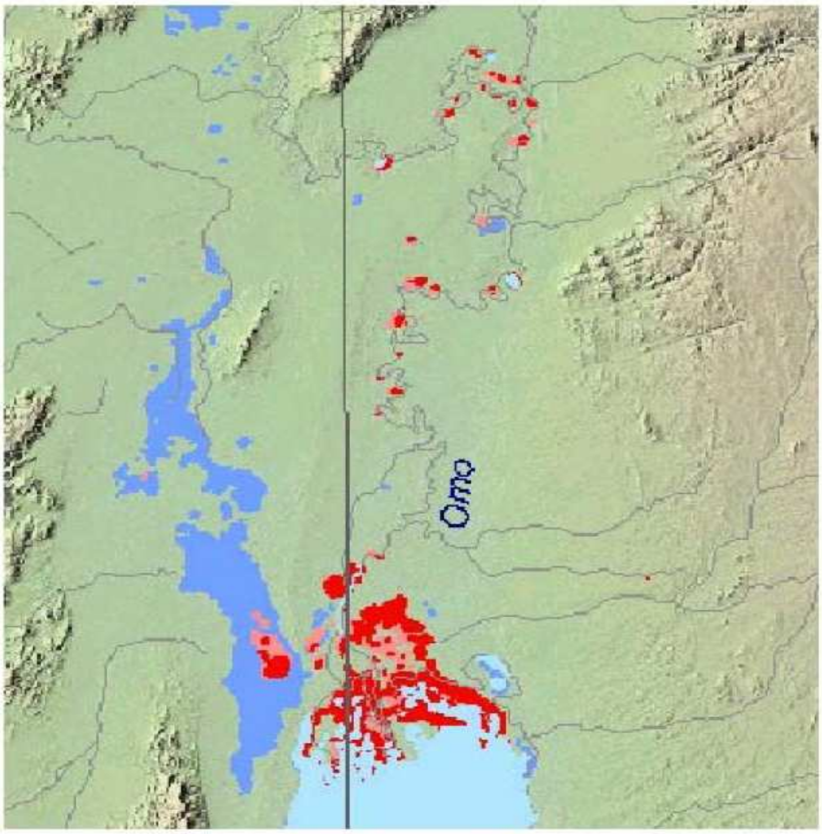
Figure 3.10: Average monthly runoffs at Gibe III, Residual and Lake Turkana

The annual peak floods discharges some kms before the Turkana section can be estimated, however with a reasonable confidence range of about +- 25% due to the few recorded data available for a flood estimate within the residual basin, to be for a 10-, 30- and 50- year return period respectively, 4800, 5800 and 6300 m^3/s.

These extreme high peak flows cause a serious threat especially to the Dasenech population having destructive effects on human and animal life, private assets and public infrastructure.

The map below illustrates the mapping of the flooded areas during the catastrophic inundation occurred in August 2006.

The measurements carried out at Gibe III during this event indicated a peak flood flow in the range of about 3500-4000 m^3/sec, being therefore a quite frequent flood with a return period of less than 10 years.



MODIS flood inundation limit
August 21, 2008: Maximum Observed Inundation
August 14, 2006: Limit 2001 – 2005:

Figure 3.11: Omo River Inundations, 2006

On the basis of the studies summarized here above the following comments can be made:

- The hydrological regime of the Omo River has been modified by the deforestation of the watershed determining higher peak floods flows with sudden variations of the water levels (i.e. from 800 to 2300 m^3/sec in about 36 hours as recorded in July 2007);
- Quite frequent floods (as for example in 2006 with a return period of less than 10 years) cause destructive effects on human and animal life, private assets and public infrastructure in the river delta;
- Evaporation losses, due to uncontrolled flooding, contribute to the current recession of the Lake Turkana;
- Extended drought periods (for example 1986-1987 ones) cause famine crisis in the Lower Omo valleys;

The following chapters of this report illustrate the detailed analysis of the benefits and impacts of the regulation of the flows due to the Gibe III reservoir construction.

3.1.5 Land cover

The land cover mapping referring to the area ranging from the Lower Omo Basin to Lake Turkana was carried out using various satellite images (see figure below) namely Landsat 7 TM false colour 543 rgb, Aster and Quickbird false colour natural taken in different periods:

Landsat, path 169 row 56 (East)	27-Jan-2000
Landsat, path 170 row 56 (West)	05-Feb-2001
Aster (North)	24-Jan-2005
Aster (South)	14-Feb-2004
Quickbird (East)	16-Jan-2005
Quickbird (West)	24-Dec 2004

An expedite field check was further executed in December 2007 in order to acquire the necessary interpretation keys (11 days).

The Land Cover map covers a 260-Km-long area, some 20 to 30-m wide, surrounding the Omo River, from the beginning of the study area to Lake Turkana.

The scope of the enclosed Land Cover map is to single out and to define the areas with different kinds of natural vegetation, be it arboreal in dry lands (woodland), or that along the river meanders (riverine forests) as well as the bush lands of varying height and density (bushland-thicket bushland-bushland sparse-shrubland), the areas with herbaceous prevalence (grassland), humid areas (marshland), the areas without or with scarce vegetation (bare soil), the waters of the Turkana lake, Omo River, the residual waters of abandoned meanders and the ancient riverbeds.

Recession agricultures in the flood areas along the Omo River and permanent agricultural land in the delta area have also been assessed. The adopted legend is as follows:

Acronym	Class	Description
RB	River Bank	Sandy river bed sediments, without vegetation
BS	Bare Soil	Terrain void of vegetation, sparse shrubland
MA	Marshland	Wet terrain with swamp vegetation
GL	Grassland	Floodplain spontaneous grass
SL	Shrubland	Bare terrain with sparse shrubs
BLS	Bushland, sparse	10 m-spaced bushes
BL	Bushland	1 – 2 m-spaced bushes
BLT	Bushland, thicket	Bushes with closing canopies
WL	Woodland	Arboreal vegetation on dry terrain
RF	Riverine Forest	Natural Forest on riverbanks
RA	Recession Agriculture	Flood Recession cultivation
CU	Cultivation	Permanent cultivation in the delta area
PL	Plantation	Abandoned plantation
VILL	Village	Village
W	Residual Water	Ox bows and abandoned river beds
TURKANA	Lake Turkana	Dry season shoreline
OMO	Omo River	Dry season river shoreline
DIPA LAKE	Dipa Lake	Ox bow semi-permanent lake

Data has been acquired and filed using GIS systems that guarantee the geographic position, the areas, perimeters and the number of polygons per each identified Land Cover class.

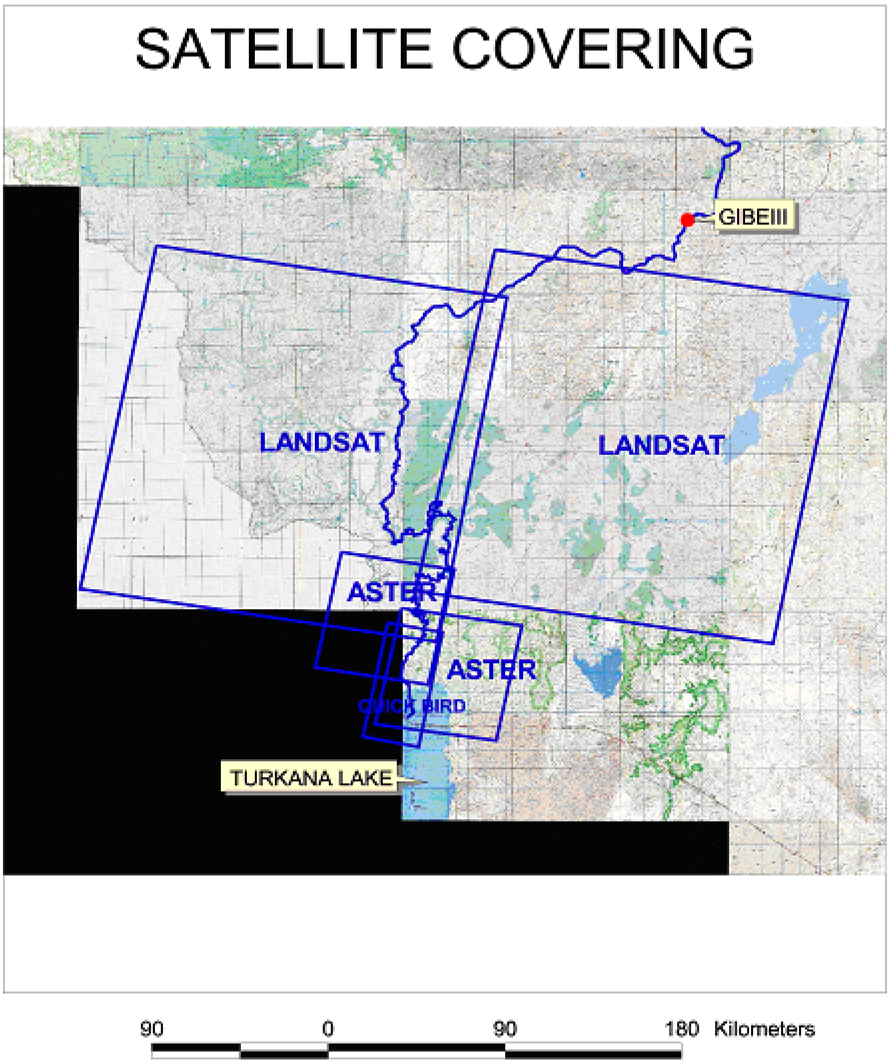


Figure 3.12: Satellite Images covering

Land Cover classes as interpreted for Gibe III downstream project area give the following figures:

Table 3.5: Extension of land Cover classes on a strip 20/30 km wide downstream Gibe III

	Dasenech	Nyangatom	B/Tsemay	Maji	Salamago	Hamer	Bacha	Decha	Total
Bushland	4829,3	30463,8	14675,4	9402,0	14790,6	1059,0	1489,7	896,4	77606,3
Bushland, sparse	17204,1	90537,5	504,7	363,8	2186,7	0,0	0,0	0,0	110796,7
Bushland, thicket	2427,9	1435,5	2381,2	0,0	27280,7	494,1	64265,4	0,0	98284,8
Bare soil	14395,0	44655,5	297,8	0,0	2532,7	2296,8	0,0	0,0	64177,7
Cultivation	4262,8	4,3	0,0	0,0	0,0	122,9	0,0	0,0	4390,1
Grassland	46269,4	30919,6	4584,0	6861,0	17500,4	4539,8	3388,3	4376,0	118438,5
Marshland	6186,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	6186,1
Plantation	2557,2	0,0	0,0	0,0	0,0	0,0	0,0	0,0	2557,2
Recess. Agricult.	437,9	280,3	0,0	84,7	173,1	54,7	18,8	6,2	1055,6
River bank	44,8	109,3	0,0	713,8	90,1	17,6	89,0	156,2	1220,8
Riverine forest	4992,1	28998,7	3224,4	386,9	1137,4	341,7	1981,5	27,4	41090,1
Shrubland	19742,6	8951,4	0,0	7184,1	21449,1	0,0	6370,7	30077,4	93775,4
Residual water	165,9	0,0	0,0	0,0	0,0	0,0	0,0	0,0	165,9
Woodland	3034,5	0,0	3756,7	18163,2	12183,8	1,8	89,4	867,0	38096,4
Total	**126549,5**	**236355,8**	**29424,2**	**43159,5**	**99324,5**	**8928,6**	**77692,9**	**36406,6**	**657841,5**

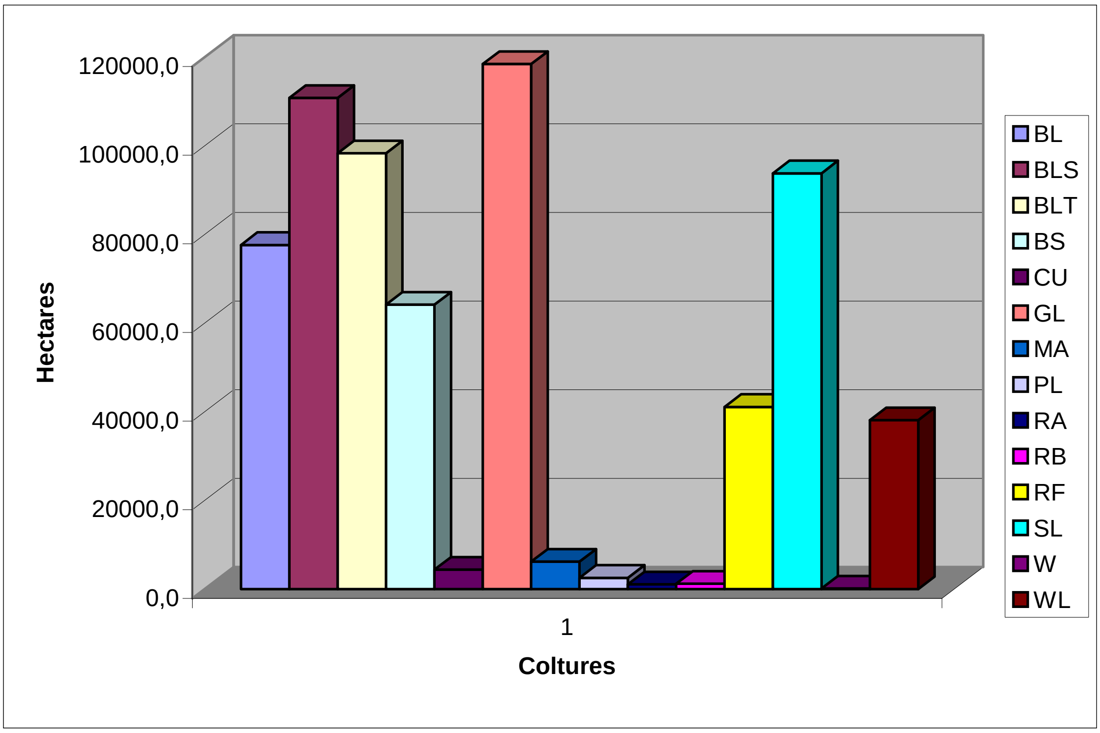


Figure 3.13: Relative extension of Land Cover Classes

Sample land Cover Features are shown in the following pictures:

Picture 1: Typical Bushland

Picture 2: Typical Recession Agriculture on River Bank

Picture 3: Typical Recession Agriculture on River Bank Detail

Picture 4: Omo River Delta

3.2 Biological Environment

3.2.1 Flora

Natural vegetation patterns and species frequency and distribution in the Lower Omo basin are greatly influenced and shaped by differences in elevation (from above 1000 m of the upper reaches of peripheral mountain ridges bordering the study area to less than 400 m at the lower end of Omo river delta) and yearly rainfall ranging respectively between 1200 and less than 300 mm/year, with the vast majority of the Omo river plains receiving less than 400 mm unevenly distributed on predominantly alluvial soils.

The river plains and associated bordering areas more directly interested by consequences related to the establishment of the Gibe III Hydropower Scheme host the following main natural vegetation ecosystems (*Omo-Gibe River Development Master Plan*), all to be found in diverse physiognomic and transition / evolution forms due to different local conditions and uneven degrees of anthropogenic disturbance and utilisation.

Somalia-Masai Acacia-Commiphora Deciduous Bushland, (climax vegetation over most of the lower Omo area, characterised by drought resistant trees and shrubs) to be found at 500-1000 m elevation, particularly between Jinka, Turmi and Omorate comprising, among the dominant small trees and bushes, *Acacia senegal*, *Acacia mellifera*, *Acacia seyal*, *Acacia tortilis*, *Commiphora africana* and other *Commiphora* spp.

Picture 5: Acacia-Commiphora Bushland

The underlying shrubs strata includes Boswellia neglecta, Boscia coriacea, Combretum aculeatum, Grewia bicolor, Balanites spp, Adenium obesum, with some characteristic succulents, such as Caralluma spp, Aloe spp, Sanseviera spp, Sarcostemma viminale and Kleinia spp also present.

The ground cover also includes species of *Acalypha*, *Barleria*, and *Aerva*.

This ecosystem is in many places under environmental stress due to extraction of fuelwood, forest fires and clearance for rainfed agriculture, and subsequent decline in regeneration capacity.

In places, excessive utilisation as free-range grazing is also causing deforestation and habitat impoverishment and fragmentation.

<u>*Lowland Dense (Thicket) Deciduous Bushland,*</u> located around 500 m elevation, this is a denser form (above 50% crown coverage) of the previous Somalia-Masai Bushland, dominated by *Acacia spp*, *Combretum aculeatum*, *Grewia bicolor* and shrubs and bushes such as *Grewia villosa*, *Acalypha fruticosa*, *Asparagus spp*. Particularly to be found on the Meki river within the Mago National Park.

In the Omo National Park, immediately behind the thin riverine forest along Omo river banks, this ecosystem is dominant and takes the local name of *Euphorbia Thicket*, including the following trees and shrubs: *Acacia polycantha*, *A. elatior*, *A. mellifera*, *Acalypha fruticosa*, *Balanites aegyptiaca*, *Maytenus senegalensis*, *Combretum molle*, *Ziziphus mucronata*. Grasses and herbs include: *Panicum maximum*, *Setaria spp*, *Ruellia spp*, *Commicarpus spp*, *Justitia spp*, *Euphorbia hirta* and *Acalypha racemosa*.

The above two vegetational formations appears to be under strong environmental stress mainly due to fuelwood removal and overgrazing by domestic cattle.

<u>*Lowland Scrubland Grassland / Open Bushland*</u>, also to be found in the elevation range around 500 m and below, either in the Mago National Park, Murle, the Mursiland, and, beyond the Omo river, in what Schoeder and Jacobs have termed “Open Woodlands” within the Omo National Park.

These shrubby grasslands have around 20% crown coverage with bush/shrub vegetation scattered or clumped within thickets of limited extension, whose main species include *Acacia mellifera*, *Combretum hereroense*, *Cordia gharaf*, *Boscia coriacea*, *Grewia tenax*, *Grewia bicolor*, *Grewia villosa*, *Ehretia coerulea*, *Adenium obesum*, with succulents such as *Sanseviera abyssinica* and *Euphorbia*.

For the same ecosystem, within the Omo National Park the following species were also recorded: *Terminalia spinosa* (dominant on low hills), *Combretum greenwayi*, *Ximenia caffra*, *Sehima nervosum*, *Cissus quadrangularis*, *Balanites aegyptiaca*.

Open bushlands of the above kinds often host large stretches of grasslands / rangelands with herbaceous specie such as *Hackelechloa sp*, *Heteropogon contortus*, *Eulalia sp*, *Setaria sp*, *Brachiaria sp*, *Chloris sp*, as well as *Panicum*, *Paspalidium*, *Andropogon*, *Dactyloctenium*, *and Hypertilia spp*. Grazing legumes include *Tephrosia*, *Rhyncosia*, *Glycinum*, *Indigofera*, *and Vigna* spp.

<u>*Lowland Semi-desert Bush and Scrubland;*</u> this vast ecosystem, greatly representative of consistent tracts of the lower Omo southern portion (3/400 mm rainfall or below), presents a broad range of different features in terms of species composition, frequency and abundance, density (thicket or sparse formations), and / or physiognomic type (bush, scrub or mainly grasslands) according to local prevailing conditions in terms of soils and human disturbances (mainly grazing).

Most of the species are highly drought tolerant, with the presence of many succulents such as *Euphorbia* and *Aloe*.

Acacia mellifera and other Acacia spp (horrida, reficient and mellifera within the Omo National Park) appear to be dominant, with Grewia tenax, Cordia gharaf, Cadaba farinosa, Clerodendron myricoides, Boswellia spp and Commiphora spp amongst the shrubs.

The lower strata, in which grasses are practically absent (with the only possible exclusion of some limited *Panicum*, *Dactyloctenium* and *Setaria spp* in the relatively more humid northern locations), includes *Cenchrus spp*, *Heliotropium spp*, *Tribulus spp*, and *Calotropis procera*, thus indicating a very scarce palatability of the substratum, possibly due to repeated overgrazing in the past and adverse climatic conditions.

The major threats to such semi-desert environment are today represented by increased grazing pressure and consequent bush encroachment.

Lowland Riverine Woodlands (Forest); this formation is to be found, in different depths, stretching along the Omo and its tributaries (Neri and Mago rivers) usually in strips of limited extension.

These often become more structured, developed and diverse particularly in correspondence of the inner (inside) portion of meandering river bends, on depressions and towards the middle portion of the Omo river delta, possibly in areas with less human disturbance and with increased soil humidity availability.

This ecosystem gradually changes its vegetational composition along drier semi-perennial tributary rivers and seasonal streams, and in its external transitional zones (mostly along the eastern banks of the Omo river delta), hosting species more distinctive of the above-described xeric environments.

Characteristic trees include Celtis integrifolia, C. zenkeri, Haplocoelum foliosum, Lepisanthes senegalensis, Melanodiscus oblongus, Tamarindus indica, Terminalia brevipes, Trichilia emetica, Ziziphus pubescent, Ficus spp, Albizia spp, Baphia abyssinica, Mimusops kummel and Phoenix spp.

Tree crown coverage may be as much as 90/100% with average height of the upper storey that may reach 20 m in favourable locations.

The understorey has been found to comprise Argomuellera macrophylla, Diospyros abyssinica, Oncoba spinosa, Phyllanthus reticulatus, Strychnos sp and Trichocladus ellipticus, while lianas and twigs include Artarbotrys, Hippocratea, Salacia, Phytolacca, and Uvaria spp.

Herbaceous strata of riverine woodlands and pastures (including the Delta) have been recorded to include the following grasses and herbs: *Eragrostis tenuifolia*, *Cynodon dactylon*, *Leptochloa rupestris*, *Brachiaria spp*, *Trifolium semipilosum* and *Oxalis cornuta*.

Within lower locations, despite proximity with water, the herbaceous strata were generally found to be not as thick and rich as might have been expected.

This is perhaps because of the excessive length of the submersion period (several months in many instances), which does not allow for seed germination and chronically inhibits photosynthesis of leaves, as demonstrated by several studies carried out on the matter (see relevant bibliography).

Eventually, within the humid grasslands of the lower portion of the Delta (seasonal swamps and marshes), characterised by gradual disappearance of riverine woodland and the rare presence of isolated shrubs, the herbaceous strata is dominated by *Sporobolus spicatus*, *Brachiaria spp* and *Leptochloa fusca*.

Although riverine woodlands show substantial crown coverage, their average density in terms of volume was found to be far from desirable.

Being more directly relevant to the aim of the present study, there follows below a few figures regarding total stem volumes as estimated in some virtual sample plot locations by the mission in the Kara Dus area:

Table 3.6: Stem Volume, Riverine Woodlands

	Basal area (m^2/ha)	Mean top height (m)	Form coefficient	Stem volume (ha)
1	6	15	0.8	72
2	5	10	0.9	45
3	5	12	0.9	54
4	5	13	0.9	58
5	6	11	0.9	59
6	11	10	0.8	88

In the above table, Basal Area values have been estimated by the use of Bitterlich Relaskope technique.

This roughly matches and confirms figures of Estimated Woody Biomass of 41-47 m^3/ha as reported within CESI EIA Main Report.

In many cases, a situation in which a narrow number of adult individuals belonging to a limited number of tree species (more resistant to longer flooding), and the relative scarcity of smaller diameter classes, may be the consequence of vegetational succession induced by excessive floods. In fact, large-scale, prolonged submersion of riparian forests always takes a heavy toll on dense forests.

Picture 6: Riparian forest in Kara Dus, Virtual Sample Plots location

Within such formations, the lush green shown by upper and under-storey is due to silt deposition from retreating floods and by accelerated litter biomass turnover and consequent nitrogen decomposition following decay taking place with residual soil moisture and the activity of soil-dwelling arthropods, once flood waters have receded.

Year-round permanence of soil moisture is also guaranteed by presence of a superficial water table originating from the nearby river.

Apart from their importance for timber production, riverine woodlands are also important for Non-Timber Forestry Products (NTFPs); as an example, in the river delta *Uvaria Leptocladon* roots are being used as a medicine while *Maerua* and *Moringa spp* are employed, once made into a paste and mixed with water, to flocculate turbidity of the river water before utilising it.

As riverine areas are also essential for traditional and cultural values, local Weredas are introducing by-laws to protect them and encourage sustainable utilisation (excluding timber harvesting and hunting, which remains prohibited).

Picture 7: Typical Riverine Forest and Permanent Cultivation nearby River Delta

Picture 8: Typical Riverine Forest and Permanent Cultivation nearby River Delta Detail

3.2.2 Wildlife resources

Comprehensive and accurate estimates of animal populations in the lower Omo basin have never been carried out.

Different studies and reports, however, indicate characteristic wild animals of the lower Omo to include elephant, buffalo, lion and giraffe. Other species reported comprise topi, eland, greater and lesser kudu, Burchell's zebra, gerenuk, oryx, waterbuck, warthogs, dikdik, Grant's gazelle, hartebeest, bushbuck, reedbuck, common duiker, oribi, jackal, wild dog, large spotted genet, white-tailed mongoose, spotted hyaena, leopard and cheetah, most of which appear to be concentrated in the lower Omo 4 protected areas and reserved forests.

Amongst primates, Olive baboon, Colobus monkey, de Brazza's monkey, blue monkey, and Grivet monkey have all been recorded.

African wild ass, Grevy's zebra and black rhinoceros (globally threatened species) may also be present in the area.

In the Omo river lower portion, hippopotamus has not been lately reported and might today exhibit very limited (if any) population due to indiscriminate hunting and conflict with local human activities (recession agriculture and cattle rearing), while crocodiles are still a common sight along the river banks.

Local key bird species include ostrich, civet, vulturine guineafowl, yellow-necked spurfowl, eastern chanting-goshawk, bustards, red-bellied parrot, white-bellied go-away-bird, red-throated bee-eater, abyssinian scimitarbill, hornbills, barbets, pygmy batis, three-streaket tchagra, taita fiscal, larks, boran cisticola, pale prinia, rufous chatterer, dusky babbler, starlings, robin-chat, sunbirds, weavers, black-rumped waxbill, steel-blue whydah, sombre nightjar, bush-shrike, grey wren-warbler, white-breasted white-eye, bare-eyed thrush, grey flycatcher, parrot-billed sparrow, white-headed buffalo-weaver, silverbill, canary, etc.

At the Zonal Headquarters of Jinka, the mission interviewed wildlife personnel in charge of hunting control, who gave the following assessment of the most common wildlife species situation in the lower Omo area:

Table 3.7: Wildlife perceived presence, Lower Omo

Wildlife utilised / hunted (in decreasing order of importance)	Local economical or dietary importance (1. very important, 2. important, 3. marginal)	Perceived presence in the local environment (1. common, 2. less common, 3. rare)	Perceived Trends compared with 10 years ago (1. increasing, 2. stable, 3. decreasing)	Comments
Buffalo	1	2	3	
Elephant	1	2	3	Hunted for ivory
Giraffe	2	3	3	Cultural importance, almost disappeared
Lesser kudu	1	1	3	Meat, skin
Waterbuck	1	1	3	
Warthog	1	1	3	Meat, medicine
Gerenook	3	2	3	
Hartebeest	2	2	3	Becoming rare
Bustard	3	2	2	Occasionally hunted for food

The above feelings are somehow confirmed by the survey undertaken by the present mission at Kebele (PAs) level, which showed, for the main species considered:

Table 3.8: Wildlife presence and trends

WILDLIFE HUNTING

1st value: Importance in local diet (1. Very important/ 2. Important/ 3. Scarce)
2nd value: Perceived presence in local environment (1. Common/ 2. Less common/ 3. Rare)
3rd value: Perceived population trend (1. Increasing/ 2. Stable/ 3. Diminishing)

Wereda	PA	Waterbuck	Buffalo	Warthog	Hartebeest	Oryx	S. Gazelle	Porcupine	Bush Duiker	Ostrich	Zebra
Salamago	Hailwuha	2/ 3/ 3	2/ 1/ 3	2/ 2/ 2							
	Omo Rombei		1/ 2/ 3		1/ 1/ 3						
	Gura		1/ 2/ 3								
	Omo Hana	1/ 3/ 3	1/ 3/ 3								
Dasenech	Bareckenche			2/ 1/ 3							
	Omo Rate										1/ 3/ 3
	Gumbebure			2/ 3/ 3		2/ 3/ 3			3/ 3/ 3		
	Arsyamoy	3/ 3/ 3	3/ 3/ 3	2/ 3/ 3	3/ 3/ 3		3/ 3/ 3	3/ 3/ 3			
	Gububur Nebir			1/ 2/ 2				2/ 3/ 3			
	Rukkuk	1/ 2/ 3	2/ 2/ 2	1/ 2/ 3			2/ 2/ 1				
	Delerele									1/ 2/ 2	
	Selegn									1/ 2/ 3	
	Kelem		1/ 3/ 3	1/ 1/ 1							
	Akudugule		1/ 3/ 1	1/ 1/ 1							
	Kolemegnato			1/ 3/ 3							
	Lobate		1/ 3/ 3	2/ 1/ 3							
	Terongola		1/ 3/ 3	2/ 1/ 3							
	Kalawa		1/ 3/ 1								
Nyangatom	Lorenkachew		2/ 3/ 3	2/ 1/ 1		2/ 3/ 3	2		2/ 2/ 2		
	Kuchuru				2/ 1/ 2						
	Naptukoyt		1/ 1/ 2	1/			1/ 1/ 2				
	Shenkora		1/ 2/ 3				1/ 2/ 2				
	Lopokor		1/ 1/ 2			1/ 1/ 2	1/ 1/ 2		1/ 1/ 2		
	Nakirman		1/ 1/ 2		1/ 1/ 2						
Hamer	Karo Duss	3/ 2/ 3		1/ 1/ 1	1/ 2/ 2				1/ 1/ 1		2/ 3/ 3
	Karo Labuk	1/ 2/ 2		1/ 1/ 1	2/ 2/ 2				2/ 2/ 2		3/ 2/ 3

The above table highlights the importance attributed to wildlife in the local diet while indicating that, according to local widespread perceptions, practically all wildlife species are undergoing a worrying trend of reduction in their overall populations.

Apart from local perceptions, progressive local decline in animal numbers has been confirmed by many scientific sources, also as a consequence of the semi-nomadic lifestyle of the population and the widespread availability of automatic weapons and small arms in general.

Further, local customary habits do not or rarely include domestic livestock in the habitual diet of those populations, which usually rely on wildlife as their main source of animal protein intake.

Due to progressive bush encroachment related to excessive rangeland livestock pressure, and consequent decrease of savannah-like formations, herbivores such as Zebra, Hartebeest, and large gazelles are reported to be diminishing their presence within the two main conservation areas (Omo and Mago National Parks) and the Mursi Lands in general.

Such wildlife appears to be concentrating in less disturbed territories further south, to the Murule Controlled Hunting Area and the open grasslands of Omorate and beyond, down to the semi arid rangelands bordering Kenya.

A synthetic survey of wildlife has also been attempted by the mission at Wereda level, in order to cross-check the above preliminary data, with the following results:

Table 3.9: Wildlife presence by Wereda

Wereda	Nyangatom	Salamago	Hamer	Dasenech
Wildlife				
Buffalo	3	2	4	3
Anubis Baboon	3		4	3
Warthog	3	2	2	3
Dik Dik	3		4	
Tora Hartebeest	3		4	
Lelwel Hartebeest		3		
Oryx	3	4	4	3
Soemmering Gazzelle	3	3		
Zebra		2		
Elephant		4	4	
Cheetah		1		
Common Waterbuck		2	4	
Lion		4	3	3
Greater Kudu		2		
Vervet Monkey		3		3
Hunting Dog		2		(3)
Black Rhinoceros			2	
Spotted Hyena			4	3
Mongoose			4	
Genet			4	3
Hare			4	
Grant Gazelle			4	
Giraffe			3	
Fox			4	
Eland			4	
Crocodile			4	
Colobus Monkey			4	3
1 rarely seen 2 seen, but not every year 3 seen every year 4 commonly seen				

Apart from the extreme dissimilarity of data rendering impossible any kind of further elaboration, it may perhaps be assumed that species mentioned by 3 / 4 Weredas would be amongst the most common (though not exclusive of other, similarly common species), while those only mentioned by 1 / 2 Weredas would be less commonly seen.

3.2.3 *Aquatic flora and fauna*

The downstream riverine environment of the Omo - Turkana basin is different from the upper reaches of the river as water speed is slower, riverbanks wider and more species diversity is to be found.

The Omo River represents the main source of freshwater inflow into Lake Turkana thus significantly contributes to the nutrient input and hence productivity of the lake.

The seasonal fluctuation in production of phytoplankton is associated with the rains and subsequent increased flows into the lake carrying the allochthonous nutrient materials. Seasonal variation in spatial distribution and density of phytoplankton has been studied in Lake Turkana (Hopson, 1982). Highest phytoplankton production occurs in the northern part of the lake area close to the Omo delta where water is less saline and more nutrients are carried into the lake by the river. Increase in phytoplankton density is in fact observed during March and December (Hopson 1982).

Phytoplankton in the lake comprises eight main species dominated by the blue green alga, Microcystis aeruginosa. Other species include Anabaenopsis arnoldii, Botryococcus braunii, Planctonema lauterbornii, Oocystis gigas, Sphaerocystis schroeteri, Coscinodiscus sp., Surirella sp. (Kolding, 1989).

Of the aquatic vegetation, the grass *Sporoborus spicatus* and *Paspalidium germinatum* are the most common emergent macrophytes observed (Omo-Gibe MPS, 1996).

The distribution of these macrophytes in the shallow lake area is very important for fish as a refuge from predators while providing a breeding and nursery ground for several fish species including *Oreochromis niloticus,* that feed on the algae encrusted on the stems and leaves of these plants.

Zooplankton species also show spatial and seasonal variation in distribution and abundance. The rotifers contribute to the food web in areas close to the delta of the Omo River (Hopson, 1982). These include the *Brachionus sp.* (five species) *Keratella tropicus Felinia terminalis* and *F. opalensis.*

Larger size crustacean zooplankton occurring in the lake includes the Copepoda (Tropodiaptomus banforanus, Mesocyclops leuckarti, Thermocyclops hyalinus) and the Cladocera (Diaphanosoma excisum, Ceriodaphnia rigaudi, Moina spp.).

There is variation in seasonal distribution and abundance among the different zooplankton species though most of such species show high abundance during March, Dec-Jan, and July-August.

In general, the diversity of zooplankton is higher in the north of the lake close to the inflow of the Omo River and the plankton is more abundant during the high water or flooding period (Omo-Gibe MPS, 1996).

The protozoa *Raphidiophrys pallida* (Heliozoa) and *Vaginicola sp.* (ciliate) are the commonest protozoa occurring in Lake Turkana waters. The protozoa are also important in the aquatic food web, and contribute more at the centre and southern parts of the lake. They show seasonal variation in density - this being high during June and August for *Raphidiophrys pallida,* and during March for *Vaginicola sp.*

The lower reaches of the Omo River represent one of the water bodies that support high fish species diversity with over 70 species described (Baron et. al 1997), which makes it second only to the adjacent Baro-Akobo river basin (that is connected to the White Nile River system in the southwest) with regard to such diversity (Golubtsov and Mina 2003).

The diversity of the fish fauna increases with river length starting from its source, and is inversely correlated to altitude (Wellcomme, 1985); hence more species are encountered in the lower reaches of the Omo River than in the upper rhythrone zone.

Important previous study reports and publications on the fish stocks and fisheries of Omo / Turkana aquatic systems include the study reports of the Joint Ethio-Russian Biological Expedition (JERBE 1984-97); Hopson, 1982; Kolding, 1989, Baron et. al. 1997, and Golubsove et. al. 2006.

The JERBE study has mainly focused on the taxonomic description of the fish species in the basin, while the others include the biology and distribution.

A major study on Lake Turkana fish stocks and fisheries was made during the period of 1972-75 by a British scientific team (Hopson, 1982). The report includes detailed information on the diversity, distribution and biology of the fish fauna of Lake Turkana.

The importance of the Omo River in contributing over 90% of the fresh water influx to the Lake Turkana and in providing breeding grounds for many of the important fish species has therein been described.

The Omo River has a wide delta forming a number of islands and vegetated shore areas that provide suitable breeding grounds for many fish species migrating from the lake.

Another significant work on the fish stocks and fisheries of Omo - Turkana Basin was done during 1995/96 by the Project "Integrated Development Master Plan Studies for the Omo - Gibe River Basin" (Report Vol. 13 Min. Water Res., 1996).

The study describes fish stocks in the water system and fishery development status at the time, identifying about 64 fish species inhabiting the Omo-Gibe river basin, with two groups (detritivorous and omnivorous) concentrating in the upper reaches of the river and 6 groups (herbivorous, detritivorous, omnivorous, bottom insectivorous, surface insectivorous and piscivorous) in the middle and lower reaches of the Omo, testifying an increase of biodiversity towards the lower Omo area.

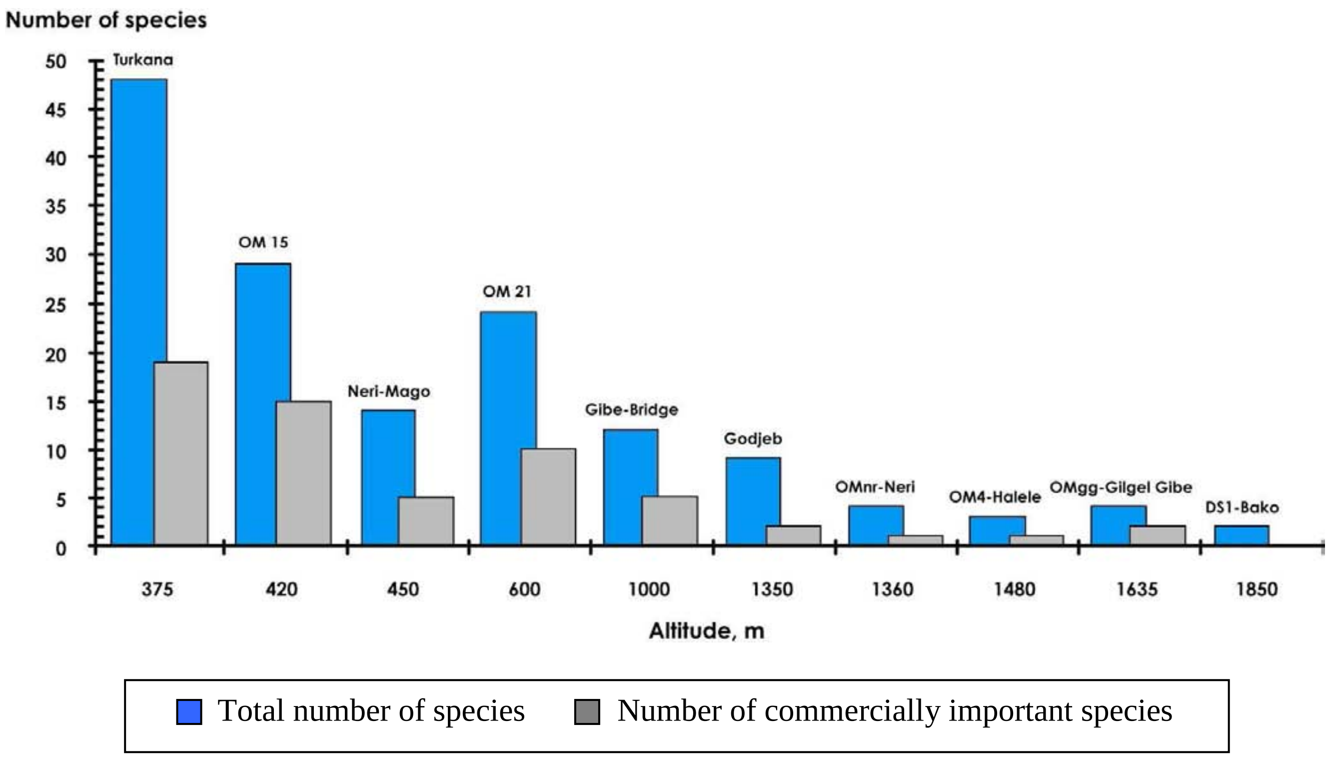


Figure 3.14: Fish Diversity, Omo River

The fishery situation however, especially in the river section between Omorate down south to Bubua village, on the shores of Lake Turkana, has changed much since the study period of 1995 as will be described in the relevant section below.

Fish species endemic to the Omo - Turkana basin have been described in different publications and reports (Hopson, 1982, Golubtsov and Mina 2003). Golubtsov and Mina 2003 have listed nine fish species vis. - Characids *Brycinus ferox*, *Brycinus minutes,* the cyprinids *Barbus turkanae*, and *Neobola stellae, Aplocheilichthys rudolfianus, Lates longispinnis, Thoracochromis macconneli, Thoracochromis rudolfianus, Thoracochromis turkanae,* endemic to the Lake Turkana and lower delta of the Omo River.

Endemic fish species breed in different locations in or close to the lake - like in the estuarine, littoral and pelagic habitats of the lake. These fish species have apparently evolved in the lake from the riverine ancestors to fill the niche created in the lacustrine system.

None of the reports referred in the studies indicate the occurrence of endangered or threatened fish species in the Omo-Turkana system.

3.2.4 Fluvial and lacustrine biodiversity

Since most of the Omo River main catchment is from 2000-3000 m, its level rises and falls every year in response to the rainfall regime of the Ethiopian highlands. It begins to rise in April or May and reaches its maximum level in August or September, when it overflows its banks in Mursiland and, more extensively, in its lower basin.

Having reached its maximum level, the river recedes rapidly during September and October, when people start preparing the recently flooded area for flood-retreat cultivation. It is at its lowest, and easily fordable at several places, by December/January, during the height of the dry season.

These extreme fluctuation patterns do not generally allow, with a few very marginal exceptions, to have permanent humid swamps and marshes, nor the establishment of major floristic or animal endemisms, thus often resulting only in more favourable locations in which (generally) the same species of the drier inland territories may flourish, or take advantage for more extended periods of time.

This can represent a limit to potential biodiversity richness that may characterise situations of more regular water flow regimes or even stagnant waters.

On the Omo main course, in its seasonal swamps and riverine ecosystems, however, the following amphibians have been registered: *Bufo regularis, Bufo chappuisi, Bufo steindachneri, Tomopterna cryptotis, Phrynobatrachus natalensis, Chiromantis kelleri, Leptopelis bocagii, Hyperolius balfouri, Hylarana galamensis,* with the presence of *Ptychadena schillukorum* being the only recorded distribution in Ethiopia.

The riverine habitat is also relatively rich, when compared with nearby ecosystems, in birds, invertebrates, reptiles, ungulates and primates, especially during the dry season, when it becomes a refuge against wildfires and anthropic disturbances.

The Omo River creates a large delta extending between Ethiopia and Kenya. This isolated and unique wetland feature has expanded by over 500 sq km in the last 15 years as measured by space-borne remote sensing techniques and corroborated by low-altitude aircraft reconnaissance flights.

This is considered to be the result of a negative global environmental situation, although the expansion of the delta wetland is potentially maintaining or increasing the local biodiversity of fauna and flora.

However, the good soils, lush vegetation, and availability of water are also attracting permanent human populations, most likely in conflict with the fauna and flora; in fact, cultivation is widespread (please refer to Land Use section and maps), while delta grasslands already appear to be over-utilised by livestock and show selective decline in wildlife.

The growth of the delta is thought to be a function of both increased sedimentation (siltation) and decreased lake levels and river flows.

The delta has been included within the Important Birds Areas (IBAs) of Ethiopia as a hotspot for bird life, both migratory and local.

The uniqueness of this isolated delta suggests that due consideration should be given to its possible protection and management.

3.2.4.1 Riverine terrestrial environment and biodiversity

This ecosystem is composed of stretches of different kinds of vegetation as previously described. In fact, riverine forests, hosting a (relatively) greater number of species compared with inland xerophytic ecosystems, often give way along the river banks to a wide array of other local typical formations of bushland and grassland, down to the aquatic reeds of the extreme portion of the delta area.

From north to south however, even within riverine bushlands, arboreal species, although being luxuriant and ever-green from the prolonged presence of more moisture (if compared with nearby dry grassland and bushland), and often closing-up their canopies within the river levee backslopes and adjacent mudflats, did not appear to show high degrees of floristic diversity as may be expected.

The diversity remained somehow limited to main species such as Ficus sycomorus, Tapura fischeri, Melanodiscus oblongus, Celtis integrifolia and Trichilia roka in upstream locations, whereas Cordia sinensis, Acacia mellifera, Ziziphus mauritiana were more commonly seen in downstream communities.

This relatively limited degree of floristic diversity, may also be due to successions caused by the seasonal heavy occurrence of bush fires set with worrying frequency by the population, cultivating and generally clearing river banks for recession agriculture and as seasonal grazing grounds (as fire stimulates re-growth of grasses), as well as by other disturbances of natural (excessive duration of flood / dryness succession) and anthropic (utilisation of timber and NTFPs and direct over-grazing) origin.

In fact, it has been suggested that fire is a highly significant factor in the establishment of sharp boundaries between the closed canopy woodland/forest along the river and the more xerophytic vegetation of the mudflats.

In the case of riverine grazing grounds, it is noted here that moving downward from the highlands to the river delta (as river banks become lower and flood plains larger thus allowing moisture to penetrate deeper inland, and the water table level to raise near the surface), the presence of greener pastures in the immediate vicinity of the river tends to increase moving towards the river delta, while deep-rooted tree species are penalised.

As far as terrestrial wildlife habitats are concerned, the riverine environment does not, in most cases represent a permanent habitat, perhaps due to excessive duration of submersion, but is rather used as temporary shelter in some periods of the year or as a refuge while accessing the river for watering, since wildlife usually prefers to remain inland, where less disturbances are likely.

Therefore, concerned wildlife personnel in the area do not presently see the riverine environment as a serious competition / conflict ground between wildlife and domestic livestock.

The riverine forest along the Omo river is however important for several different bird groups, including herons and egrets, kingfishers, barbets, chats and thrushes, woodpeckers, pigeons, shrikes, warblers and flycatchers. *Halcyon malimbica* is a recent discovery in these forests.

From a biodiversity point of view, this environment is also significant for small mammals; the Carnegie Museum of Natural History, in fact, carried out in 1978 a study on the rodent fauna of the lower Omo valley that showed the following rodent distribution patterns:

Table 3.10: Rodent fauna, riverine environment

	Riverine areas		Arid zones		
Species captured	With trees and shrubs	Without trees, with grass and thickets	Slopes	Bottom	Plateau
Xerus rutilus				1	5
Tatera nigricauda	4	11		2	8
Tatera minuscula				2	1
Tarerillus harringtoni		1		2	3
Gerbillus pulvinatus					27
Gerbillus pusillus				3	6
Saccostomus mearnsi		9			
Mastomys erythroleucus	2	3			
Arvicanthis niloticus	11	2			
Arvicanthis somalicus		7		5	
Acomys percevali		4	3	16	3
Acomys wilsoni	2	16			9
Total specimens	19	53	3	31	62
Number of trap-nights	640	1,880	290	630	1,711

This may hint at the relative abundance of such small mammals within riverine environments, if compared with less biomass-productive inland ecosystems, especially under grasses and thickets more than under forest cover (possibly as a consequence of such latter areas more likely getting flooded), with densities comparable to their presence on the nearby plateau.

3.2.4.2 River Aquatic Biodiversity Rapid Assessment

A rapid River Habitat Assessment (Habitat Integrity Assessment) has been carried out by the Mission at three selected locations, representative of the three main geomorphologic units (Chainages 200-350, 350-660, and 660-750), these being: Salamago, Kara Korocho, and River Delta with a similar methodology as that employed by CESI for the main EIA Report, using EPA (USA) Rapid Bioassessment Protocol (para 5.2.3.2. of EIA Report: Habitat Integrity Rating).

Under this widely used methodology it is considered that river habitats are closely linked to potential biological diversity, since quality of the habitat influences structure and function of the aquatic community in a river and presence of an altered habitat structure is a factor of stress for aquatic ecosystems.

Collected physical characteristics and water quality information (to be differentiated between high and low gradient rivers) include assessment of epifaunal substrate / available cover, river embeddedness, pool substrate characterisation, velocity / depth combinations, pool variability, sediment deposition, channel flow status, channel alteration, frequency of riffles (or bends), channel sinuosity, bank stability, bank vegetative protection, and riparian zone vegetative width.

The above data are ranked and scored to a maximum of 200 points, giving indication on the degree to which potential biodiversity values may differ from "optimum".

Findings of the said rapid assessments gave the following scoring:

Location	Score	Chainage
Ayloha (Salamago)	91/200	200-350
Kara Korocho (Dis)	73/200	350-660
Toitella (Omorate)	153/200	660-750

While full Visual Based Rapid Habitat Assessments sheets for the three identified locations are given in an Appendix 2 to the present report, summary tables of findings are given below:

Ayloha Kebele, Salamago		**See Appendix 2.1**
Parameter	Score	Score max
Epifaunal Substrate	6	20
Embeddedness	4	20
Velocity / depth regimes	9	20
Sediment deposition	9	20
Channel flow status	12	20
Channel alteration	19	20
Frequency of riffles (or bends)	8	20
Bank stability	10	20
Vegetative protection	8	20
Riparian vegetative width	6	20
Total score	91	200

Kara Korocho, Hamer		**See Appendix 2.2**
Parameter	Score	Score max
Epifaunal Substrate	3	20
Pool substrate characterisation	8	20
Pool variability	3	20
Sediment deposition	13	20
Channel flow status	7	20
Channel alteration	18	20
Channel sinuosity	7	20
Bank stability	6	20
Vegetative protection	4	20
Riparian vegetative width	4	20
Total score	73	200

Toitella Village, Omorate		**See Appendix 2.3**
Parameter	Score	Score max
Epifaunal Substrate	9	20
Pool substrate characterisation	14	20
Pool variability	19	20
Sediment deposition	9	20
Channel flow status	20	20
Channel alteration	20	20
Channel sinuosity	14	20
Bank stability	18	20
Vegetative protection	14	20
Riparian vegetative width	16	20
Total score	153	200

Relative changes in adopted parameters between the first and the subsequent two tables represent methodological adjustments to different river gradients (high and low gradient rivers).

The above assessment prompts some very broad considerations by hinting that the Omo river potential aquatic biodiversity generally increases from north to south, due to enlargement in river widths and therefore decrease in speed of flow, reduction in height of river banks (with more vegetation approaching the water), greater availability of nutrients, etc.

All in all, however, potential biodiversity (excluding the delta area) remains, under the present conditions, limited, mainly due to the high variability of unfavourable conditions of unregulated river flows.

The practical absence of vegetation cover along most of the river banks, due to both excessive flash flow regimes and recession agricultural cultivation practices increases local erosion and contributes to river siltation and water turbidity, from locally produced sediments and from those coming from places of higher precipitation in the Ethiopian highlands.

As a result, continuous and sustained sediment deposition buries downstream bentic communities, while movement of coarse particles during the rainy season, due to increased water speed, scrape the bodies of aquatic animals and polish river banks and submerged river bed, not allowing, *inter alia*, sufficient algae growth.

This negative physical action, coupled with heavy water year-round turbidity, effectively inhibits photosynthesis for algae development, and therefore limits oxygen formation and hence biodiversity potentials.

3.2.4.3 Seasonal Swamps and Lakes

These are composed, in most cases, of low lying areas being remnants of the river's past different meandering system which, due to progressive dryness of the environment and diminished rainfalls has now been almost completely excluded from the-nowadays reduced Omo-Gibe hydrographic system.

Such is the case, for example, of the old Murdizi branch which, starting about 6 km north of Omorate makes its way to the east and then heads south, entering the lake at Nagum. Nowadays this branch does not carry any water even during exceptional floods, but was probably still flooded in the '50s.

Other, more limited areas, still get temporarily flooded most of the years, causing seasonal marshes utilised for fishing with fishes getting trapped in it from the river's overflowing waters, and enabling recession agriculture and dry season grazing as water levels shrink down to complete disappearance in the dry season.

This is largely true for Lakes such as Dipa in Kara Korocho Kebele, Shoshe in Kara Lebuk Kebele, and Wala in the Hamer Wereda.

In the case of Dipa at least, the depression is reported of late experiencing years in which reduced river floods do not suffice for water overflowing into it, while soil nature does not allow underneath seepage from the river either.

These temporary marshes, utilised from immemorial times for agricultural and livestock exploitation by the local population in an environment otherwise scarcely endowed with usable resources, appear to be heavily anthropised and, although being of undeniable importance for the local economy, do not seem to constitute particularly significant or vital biodiversity or habitat hotspots, possibly excluding their local importance as breeding grounds for fish and amphibians.

In the main seasonal marsh of Dipa, in fact, as water entirely disappears, aquatic life ceases completely in the dry season, thus not allowing any local permanence of fish, while surrounding vegetation is not represented by riverine habitats but rather by the usual locally dominant xeromorphic Lowland Semi-desert Bush and Scrubland ecosystem (see photo).

Picture 9: Dipa Lake

In general terms, such seasonal swamps do not seems to be important fauna or flora specific habitats, while may represent *non-exclusive* spawning grounds for some migratory fish species.

Otherwise there would not seem to be important or unique advantages for terrestrial wildlife utilising such places, other than drinking.

3.2.5 Fish stocks and Fishery

3.2.5.1 Fish stocks

Studies on the biology of the local fish species have shown that they have different seasonal and spatial distribution and requirements for optimal growth – feeding, reproduction and survival.

Some species undergo seasonal migration from the lake feeding grounds to spawn in the Omo River – like *Distichodus niloticus, Labeo horie*. Others prepare their own spawning sites (nests) close to the vegetated shore areas of the lake and complete their life cycle (*Oreochromis niloticus*). There are also fish species that spawn in the lake or in the river systems (*Hydrocynus forskalii*).

Large predators, such as *Hyrocynus vitatus*, together with Nile perch and the Cyprinids, *Barbus* and *Labeo sp*. are known to exhibit extensive migration in the Omo River. The Mormyrids (elephant fish), some catfish and most Cyprinids start their spawning migration as the fresh flood water first appears.

The arrival of the first flood is assumed to trigger the longitudinal migration in these species (Omo-Gibe MPS, 1996). Three types of spawning migrations have been described as manifested by the different fish species.

These include the longitudinal migration along the river channel to spawn in the open river (Nile Perch, Cyprinids) or undergo lateral migration to spawn in the flood plains or pools (catfish), while the third one performs a more localized (or limited) migration into the vegetated lake shore area and builds spawning nests giving parental care to the offspring (Tilapia).

The most important fish species present in the fishery catch in the course of the present field study, as well as for those indicated as commonly occurring in the fishery by local fishers and fish traders, have been listed in the table below to show different types of spawning and migratory behaviour.

Table 3.11: Fish species occurring in the downstream Omo - Turkana water system

(observed in the landings and identified by local fishers as important in the commercial catch. (Data extracted from Hopson, 1982)

	Scientific and English names	Local Names	Spawning site	Spawn season	Distribution	Remark
1	Oreochromis niloticus	Letepele, Kartach, Kelete	Lake shore, pools	Continuous	Inshore, river	+++
2	Nile perch	Ruda, Hedgi	Open lake and R. Omo	Continuous	Pelagic, and R. Omo	+++
3	Clarias	Pudré, Uruf	River mouth	Flood season	Inshore	++
4	Hterotis niloticus	Negecho, Dethé	Omo delta	Aug – Sept.	Inshore	+++
5	Bagrus bayad	Arzala, Lish	Open lake and River	Apr - July (rainy season)	Lake and river	+++
6	Schiilbe uranoscopus	Meilelo	Delta and R. Omo	July, Sept, Nov	Lake and river	+++
7	Citharinus citharus	Chokoda, Yoch	R. Omo only	Flood season	Inshore and R Omo	+++
8	Synodontis schall	Digiro, lulkaskoi	Inshore and R.Omo	Flood season	Lake and river	+
9	Labeo horie		Lake and R. Omo	Flood season	Lake and river	++
10	Hydrocynus forskalii	Koronesh, Qorangesh	Lake and Omo R	Flood season	Lake and river	+++
11	Alestes dentex		R Omo only	April – August	Lakeand river	++
12	Distichodus niloticus	Golo	R. Omo only	Flood season	Littoral zone, R Omo	+++
13	Barbus bynni	Barmecha, Ginte	R. Omo only	Flood season	Flood season	++
14	Alestes ferox		Open lake	Flood season	Lake and river	++
15	Malapterurus	Kishel	Inshore and floodplain	Rainy season	Lake and river	+
16	Mormyrus sp.	Achumulo	Omo delta	Rainy season	Lake and river	+
17	Hyperopisus bebe		Omo delta and river	Flood season	Lake and river	++

Apr - August (rainy season)
+++ = Commercial importance as indicated by the fishers
One species may have different local names by different communities

The spawning period of many fish species in the river and Lake Turkana takes place with the period presently going from June (rising waters within the river) to August-September (flood period) in a biological process that lasts three to four months including the phases of water rising, flooding, and water receding.

It has been shown that extreme hydrological conditions such as failures in flooding of rivers have disrupted or resulted in poor recruitment of several fish species (Wellcomme, 1985).

This was confirmed by the poor recruitment of *Hydrocynus brevis* and lack of recruitment for *Citharinus citharus* due to failure of flooding in the Senegal River.

Shoreward migration and onset of spawning activities by *Clarias gariepinus* at the beginning of the heavy rains and inundation of the shore area was evident in Lake Tana, Ethiopia (Wudneh, 1998).

Similarly, the breeding season of *Bagrus bayad* coincides with the rainfall in Lake Turkana, where the rivers enter the lake, turbidity increases and conductivity drops.

It is said that a volatile oil, Petrichor, released when dry ground is inundated by floodwater may induce fish to breed (Lake, 1967).

3.2.5.2 The Fishery

Although the vast majority of the local human population rely on livestock resources to cover proteins requirements within their diet, almost all communities settled close to the river bank are used to consume fish, with subsistence fishing using traditional methods and single hook / line fishing being most common in the area.

However, some tribes like the Bacha in Salamago Wereda, the Karo in Hamar and the Dasenech community bordering Lake Turkana at the Bubua village are more dependent on fishery resources for food as well as an income generation activity.

Fishing is also important around Omorate town and the river delta where fishers are organized into cooperatives and the commercial fishing industry represents a fast growing local reality.

Fishery in the study area includes: the riverine fishery along mainstream Omo River, flood plain fishery, and lacustrine fishery at Lake Turkana (Bubua and Toltale).

Riverine and flood plain fishery

The fishery on the Omo River extends from the Salamago (Hana town) at the north to the south of Omorate (Toltale) at the river delta. As indicated above, there are several ethnic communities dwelling along the river with different cultures towards fish consumption.

For what concerns the middle reaches of the Omo, in the Salamago and Hamer Weredas, the Bacha and Karo communities, respectively, are the two major groups depending on fishing from the Omo River and its floodplains for both their own consumption and/or limited marketing.

Earlier study reports indicate that the Bacha tribe relies exclusively upon fish for its existence (Report MPS, 1996). Observations made in the course of the current field visit and discussions held with community members also indicate and confirm the importance of riverine fishing in the livelihood of this community.

The Mursi ethnic group in Salamago is less engaged in fishing or fish consumption, an activity that is mainly carried out by young boys.

The Karo ethnic community (locally, kara meaning fish) are settled mainly along the banks of the Omo River, organised in three Peasant Associations, - Kara Dus, Kara Korocho, and Kara Lobuk – all equally very much used to fishing and fish eating.

These communities do not usually possess cattle and depend only on fishing for protein supply in their food, with maize and sorghum being their main staple diet. Getting financial gain from fish sale, however, is very difficult and is not expected as selling fish locally is not much developed.

Kara Lobuk is about 100 km from the nearest town of Dimeka and transportation remains a constraint in the area. In spite of the fishing and consumption culture of the Karo, they do not apply any sort of fish processing or preservation practices like drying or smoking fish as noted in other areas like the Baro River fisheries, or even further south by the Dasenech community in Bubua locality for the Lake Turkana fishery.

Main fish species in the catch that were observed at some sites visited, and those that were identified by the fishers from fish pictures are listed in the above table.

Traditional fishing devices like spear fishing, harpoons, fish traps made from local materials, cast nets and single hook and line are used as fishing gear and methods. Some dugout canoes were observed on river banks but most fishers operate directly from river banks.

Picture 10: Dugout canoe used for fishing at the Omo River

Spear fishing is mainly used for catching fish stranded in pools and lagoons during the flood retreat. Fishing is practiced year round in most areas but more fishing activity is reported during the dry low water season in riverine fishery.

In total it could be estimated that there are up to 4500 fishers within the four Wereda Admin that depend on riverine fishery as an essential source of food supply in their diet and fetch limited income for the different ethnic communities - mainly the Bacha, Karo and Dasenech. (See following table).

This is based on the discussions held with the community and the local Administration, reports from earlier studies and the response from the questionnaires filled by the Weredas and PA's.

Table 3.12: Estimate of direct dependents on fishing in downstream Omo River

No.	Wereda Admin	Community/ PA	Population
1	Salamago	Bacha	700
2	Hamer	Karo	1725
3	Nyangatom		130
4	Dasenech	Dasenech	2000
			4555

Fish species most common in the catch from the river and floodplain are similar to those from the lake and comprise about 10 to 15 different types, according to the fishers and the local Agricultural Officer.

Dipa Lake is an important seasonal water body, with an area of about 60 ha, in the Hamer Wereda that has good fishing grounds and high fish stock potential according to information by the local community. It contains similar fish diversity as the Omo River and the Nile perch is more abundant. During the field visit to the site several boys were seen fishing and the catch contained good size Nile perch *(Lates niloticus)* and tiger fish, *Hydrocynus sp***.**

The area of the lake varies with season as it is filled up by the flooding of the Omo River annually. It supports about 200 household taking advantage of seasonal fishing. The Karo ethnic community, with good fishing culture, are settled around the lake.

Picture 11: Fish caught from Dipa Lake in Hamer Wereda - Karo fishers - Nile perch and tiger fish (*Hydrocynus forscalii*)

Lacustrine fishery

Lacustrine fishery takes place in the Omo delta and Lake Turkana and has relatively more fishing activity, as indicated above, than the fishery practices along the river course. This area is part of the Dasenech Wereda administration.

As was observed during the field survey and on the basis of limited data and information gathered from concerned local offices and stakeholders, fishery at the Omo delta and Turkana Lake has expanded to a fair commercial scale recently.

Fishers have been organized in cooperatives and given technical training and improved fishing gears by the Regional Bureau of Agriculture.

This recent development in the area has improved awareness of the community in recognizing the importance of fish resources of the Omo River and Lake Turkana, as it provides income and creates job opportunities apart from serving as protein food supply to the community.

At Omorate town, in Dasenech Wereda, there are registered fish trading companies that collect (receive) fish from cooperatives and individual fishers for shipment to markets outside the area. At the time of the field visit there were two companies with cold store facilities, at Bubua and Omorate and a third larger one under construction again in Omorate.

Picture 12: FPME Cold store at Omorate

Fishers in this area have limited market outlet for their catch through these few fish buying companies at Omorate and Bubua localities. These buyers have different fishing groups that work (fish) for them and prices offered vary among the buyers and landing sites.

The price at landing sites ranges from 9.0 to 7.0 B/kg fillet for Nile perch (best preferred) to 4.0 B/kg fillet for other fishes. Some buy fish in pieces (whole fish) and offer lower prices (see Table below). Due to limited fish market facilities in the area and the limited capacity of the fishers, prices are mainly fixed by the buyers rather than the fishers, who have virtually no bargaining power.

Table 3.13: Prices offered to the fishing cooperatives at landing site

	Product	Buyer Company (price Birr/kg)		Remarks
		[1]FPME	[2]Omo Fish	
1	Nile perch	9.00	7.00	Fillet
2	Tilapia	4.00	0.80	Whole fish for Omo Fish
3	Bagrus	4.00	4.00	Fillet
4	Hetrotis	4.00	4.00	
5	Labeo, Barbus	4.00	4.00	
6	Clarias	4.00	4.00	
7	Citharinus	4.00	4.00	
8	others	4.00	4.00	

1 – Fish Production and Marketing Enterprise - is a government owned enterprise
2 – Omo Fish is a private enterprise

A one year (2006-7) data record of the amount of fish purchased and shipped to Addis by the Fish Production and Marketing Enterprise (FPME) is shown below.

This gives an indication of the amount of fish sold during the period and the income obtained by the fishers. Fish sold locally to consumers and taken for home consumption is not included.

The Mission observations to Bubua landing site, Lake Turkana, indicated a good landing of Nile perch with individual fish size ranging from 65 to 90 kg in weight and 150 - 196 cm in length.

Picture 13: Fish catch being landed at the Bubua site of the Lake Turkana fishery (Total length measured 196 cm and weight 85 kg for the largest one)

Occurrence of such large (old) size group of Nile perch in the catch is an indication of the very low fishing pressure at the moment, testifying a high fish population and good potential for fishery expansion in that area of the lake.

Nile perch is the highest valued fish in the fishery, with retail price range in Addis Ababa of 50-60 B/kg fillet.

Table 3.14: Fish type and amount purchased by FPME at Toltale landing site Turkana and Omorate from the Omo River (kg fillet)

	1999 (E.C) (2006/7)	Ruda or Hedgi	Arzala, Lish	Golo		Negecho	Total fillet kg	*Est. Whole fish wt. kg (equivalent)
	Month	NP	Bagrus	Distic/ Cith	Barb/ labeo	Heter-otis		
1	Ham-July	6609	-	-	-	-	6609	19827
2	Neh-Aug	1271	-	-	-	-	1271	3813
3	Mes-Sept	3249	-	-	-		3249	9747
4	Tik-Oct	4373	22	-	-	-	4395	13185
5	Hid -Nov	3753	-	-	-	-	3753	11259
6	Tah-Dec	1633	-	-	-	-	1633	4899
7	Tir -Jan	1748	19	23	-	-	1790	5370
8	Yek-Feb	1070	6	24	-	-	1100	3300
9	Meg-Mar	1579	46	49	206	3	1883	5649
10	Mia-Apr	1944	17	130	82	7	2180	6540
11	Gin-May	3974	16	32	13	16	4051	12153
12	Sene-June	5131	14	146	7	11	5309	15930
	Total	36334	140	404	308	37	37223	111,672

**Conversion from fillet to whole fish was done assuming an average of 30% yield.*
Data does not include the catch collected by other two fish trading companies in the area.

3.2.6 National Parks and other protected areas

Listed below are the main four protected areas which are subject of the Study, showing their main characteristics.

For what concerns Maze and Chabera Corcora National Parks, located immediately below the proposed Gibe III Hydropower Project within chainage 0-200 (no flooded areas), though formally gazetted, the two PAs have not yet been physically established on the ground. Since their localization excludes the occurrence of downstream impacts, they have not been covered by the present study.

3.2.6.1 Primary Wildlife Conservation Areas (Omo and Mago National Parks)

Omo National Park

The Omo National Park is located in the west bank of the Omo river, lower Omo valley, from the Sarum plains in the north to the Neruzr river in the south, and includes the Maji mountains and Sai plains in the north and west, and Lilibai plains and Dirga hills to the south.

The Mui river crosses the Park towards its middle portion before draining into the Omo.

The Park extends to some 4068 km^2 (140 km long and 60 km wide) and is situated at an altitudinal range between 450 and 1540 m.

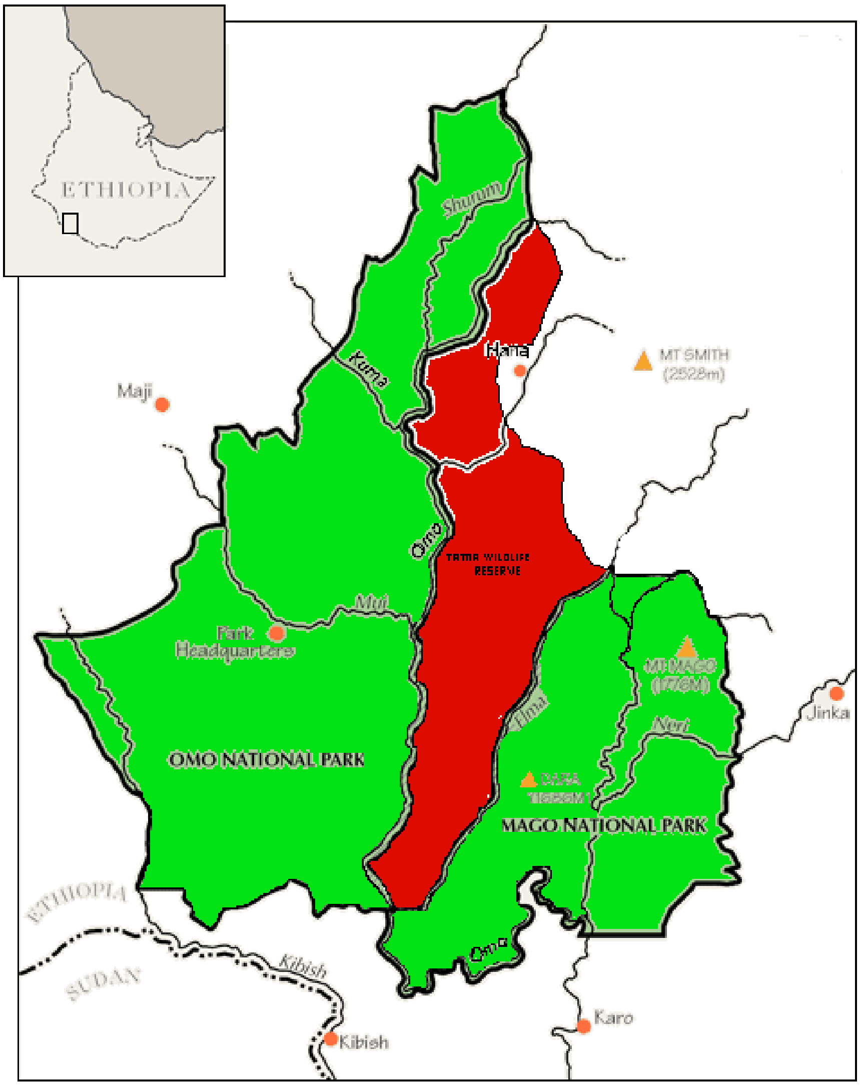


Figure 3.15: Omo and Mago National Parks, Tama Wildlife Reserve

Its vegetation ecosystems include deciduous dense and open (sparse) bushlands and thickets (Euphorbia), shrublands, and towards the edges of the Omo River, stretch of riverine forests.

These often give way to open shrubland and grasslands where most of the local people concentrate (Surma, Kwegu, and Dizi) often on a permanent basis, with Bume / Dasenech people utilising the southernmost areas and Mursi crossing the river from the east during the dry season. Due to scarcity of communication network (roads, bridges, ferry), very few if any tourists visit the Park every given year.

Talks with the Park Management staff revealed that on the riverbanks a considerable amount of recession agriculture takes place from October onward, with greener pastures near the river being utilised for livestock grazing sometimes up to March, though not on a large scale, as grazing grasslands are limited by the Euphorbia thickets characterising the interior of the Park.

With the presence of people around the river however, due to recession agriculture, illegal hunting takes place for meat, skins, and items to sell (eg. elephant tusks), while fires are also often started to clear dense bush along the river bank, sometimes running over large areas.

Damage to wildlife by illegal hunting has now reached such an extent that the Park Management estimates that this protected area may at present harbour, as an example, populations of less than 20 giraffe and about 30 hartebeest only, while zebra and rhino appear to be locally extinct.

The elephant population, on the other hand, is still rather robust with some 2/300 individuals, as this species still dominates dense bush land and thickets.

Damage of present degree of retreat cultivation to wildlife, *per-se*, is not excessive and should not be overstated as it may even be useful in checking undesirable grow of thorny / unpalatable species which may even hamper the ability of wildlife to reach water.

Damage to wildlife is more linked, instead, to the very presence of hunter / gatherers / pastoralists on the territory, as well as on direct conflicts between livestock and wildlife.

Mago National Park

Mago National Park is established upon an area of 21,620 km^2, adjacent to the Omo National Park. In its east are the Mursi Hills, rising to over 1,600 m. North of the Neri river are the Mago mountains with the highest point, Mt Mago, at 2,528 m.

The south-eastern quarter of the Park is crossed by many small streams and rivers. The headquarters for the Park are by the Neri river, near the entrance from Jinka.

To the west is the Tama Wildlife Reserve, with the Tama river forming the boundary. South of the Omo river is the Murule Controlled Hunting Area, which contains Lake Dipa.

The Mago river flows through the centre of the Park and joins the Neri river at Mago swamp, before continuing southwards as the Usno to join the Omo river.

The Mago and Neri rivers are the main sources of floods in the Park, together with flood water from the Omo entering the Usno, up to the Mago swamps, in periods of high water flows.

Vegetational features include bushland, scrubland and savannah grasslands, riverine forests, and seasonal wetlands around Mago swamp (south of the confluence between Mago and Neri rivers).

The largest trees are found in the riverine forest beside the Omo, Mago and Neri.

Wildlife include about 74 species of mammals, including important populations of elephant, buffalo, Tiang, Baboon and lesser kudu, with Gerenuk more concentrated in the southern half of the Park. More rare species include Greater kudu, Hartebeest, Oryx, Grant’s Gazelle, with some waterbuck, bushbuck and duiker more concentrated along the rivers.

Other species are Klipspringer, Warthog, Bushpig, Lion, Leopard, Cheetah, wild dog, Caracal, Fox, and Colobus and Grivet monkeys, especially within denser forests by the rivers.

A number of local tribes inhabit and use lands within the Park, including Hamer in the south-east, practicing retreat agriculture by the rivers, shifting cultivation on higher escarpments, and grazing flocks of goats and cattle within the highlands and greener areas around the rivers.

In the north-eastern portion of the protected area are the Benna (related to Hamer). The Karo, the Muguji and the Kwegu inhabit Omo riverbanks.

On the east of Mago river, between the Mursi escarpment and the Omo river in the south (Bongosa) are the lands of the Mursi, also practicing pastoralism and cultivating the Omo river banks within the Mago National Park.

Also in this area, main conservation issues include flood-retreat cultivation, pastoralism, and illegal hunting.

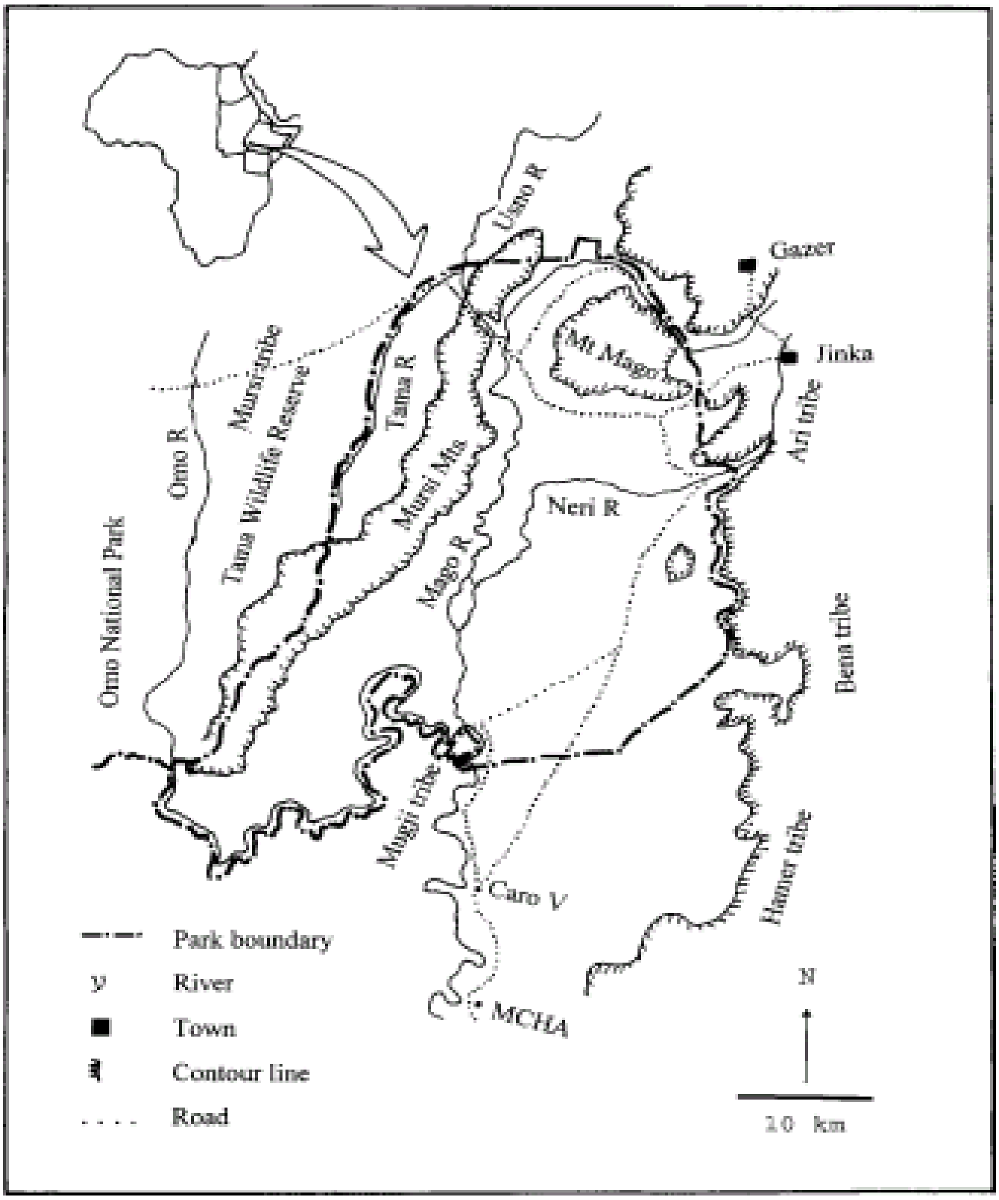


Figure 3.16: Mago National Park map

3.2.6.2 Secondary Wildlife Conservation Areas (Murule Controlled Hunting Area, Tama Wildlife Reserve)

Tama Wildlife Reserve

Tama Wildlife reserve extends over 3269 Km2 between Omo and Mago National Parks, which represents an important biodiversity corridor and with which it forms part of a unique ecosystem.

The area features ecosystems pertaining to the *Acacia-Commiphora* woodland and *Combretum-Terminalia* woodland and savannah; major wild animal species conserved include Giraffe, Burchell's Zebra, and Lelwel Hartebeest.

At present however, not many conservation / management efforts or wildlife activities take place within the Reserve, which has no EWCO personnel and infrastructures in place, and is managed by the Regional Tourism and Park Agency from the Southern Nations Capital city of Awassa.

Murule Controlled Hunting Area

Murule Controlled Hunting Area extends over 4172 Km^2 of semi-desert scrubland and *Combretum-Terminalia* woodland south of Mago National Park and east of the Omo river down to the Kenyan border.

This is a private concession managed from an office in Turmi allowing controlled trophy hunting of several wildlife species.

Major wildlife species conserved in this area include: Topi, Buffalo, Tiang, Oryx, Grant's Gazelle, Greater and Lesser Kudu, Gerenuk, Lion, Leopard, Cheetah, Crocodile and Ostrich.
The area is known to hold about 150 species of birds.

3.3 Socio-Economic Environment

3.3.1 Population and settlement

The South Omo Zone is regarded as a typical marginalized region, where infrastructure and social services are still not as developed as in other parts of the country. The pastoral part of South Omo Zone is one of the remotest and most sparsely populated areas in Ethiopia.

After descending from the Ethiopian highlands, the Omo River forms the eastern boundary of the large grass plains where the Omo National Park has been established. Further south, it meanders through the arid scrub plains of Dasenech and Hamer Weredas, forming the eastern boundary of the territory of the semi-nomadic Nyangatom people.

The downstream project area is occupied by 4 Wereda: Salamago, Nyangatom, Hamer and Dasenech.

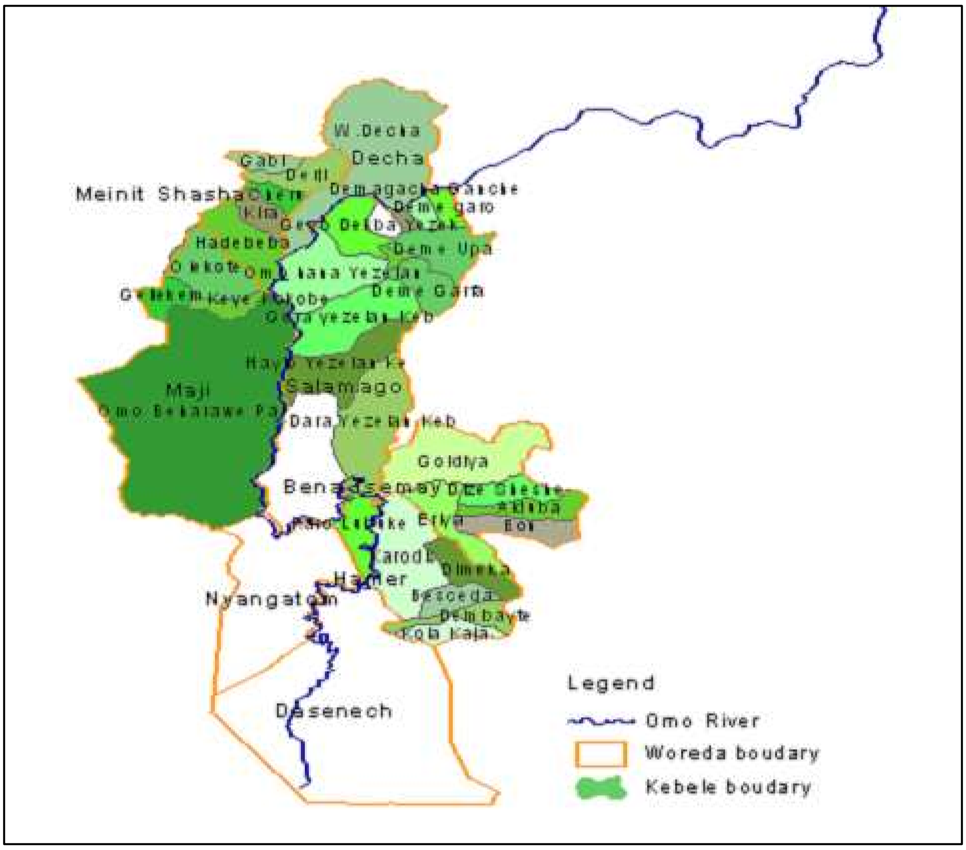


Figure 3.17: Administrative map of downstream Weredas and Kebele*

** Kebeles GIS data are not available for Nyangatom and Dasenech Weredas*

The population is estimated to grow at a rate of 2.9% per annum. Census data shows that there are about 28,713 households with an average of 4.5 people per household. Ethnic identity is another important attribute of a population.

The people of the SNNPRS are composed of 16 distinct ethnic groups belonging to Omotic, Kushetic, Semitic, and Nile Sahara linguistic families, more detailed information is provided under the appropriate headings below.

The total population in the 4 Wereda amount to 131,633, of which about 50% are economically active (ages 12-64), 45% are youth (ages 0-14) and 2% are elders. Thus about 47% of the population is dependent on the other 53% of the population.

As explained in the following table, Nyangatom and Salamago Weredas are both divided into 20 administrative Kebeles, whereas the more populated Hamer and Dasenech Weredas include 35 and 40 Kebeles respectively.

Table 3.15: Rural and Urban population by sex (2005)

Wereda	Urban			Rural			Total			House-holds	Persons per Household
	Male	Female	Total	Male	Female	Total	Male	Female	Total		
Salamago	465	244	709	9039	9584	18662	9504	9828	19332	5008	3,9
Dasenech	1818	1501	3320	22013	21146	43159	22832	22647	46479	9312	5,0
Nyangatom	0	0	0	11059	11057	22117	11059	11057	22117	4278	5,2
Hamer	1546	1238	2784	20143	20579	40722	21689	21817	43505	10115	4,3

Source: Field survey made by MDI Engineering and Agriconsulting Spa.

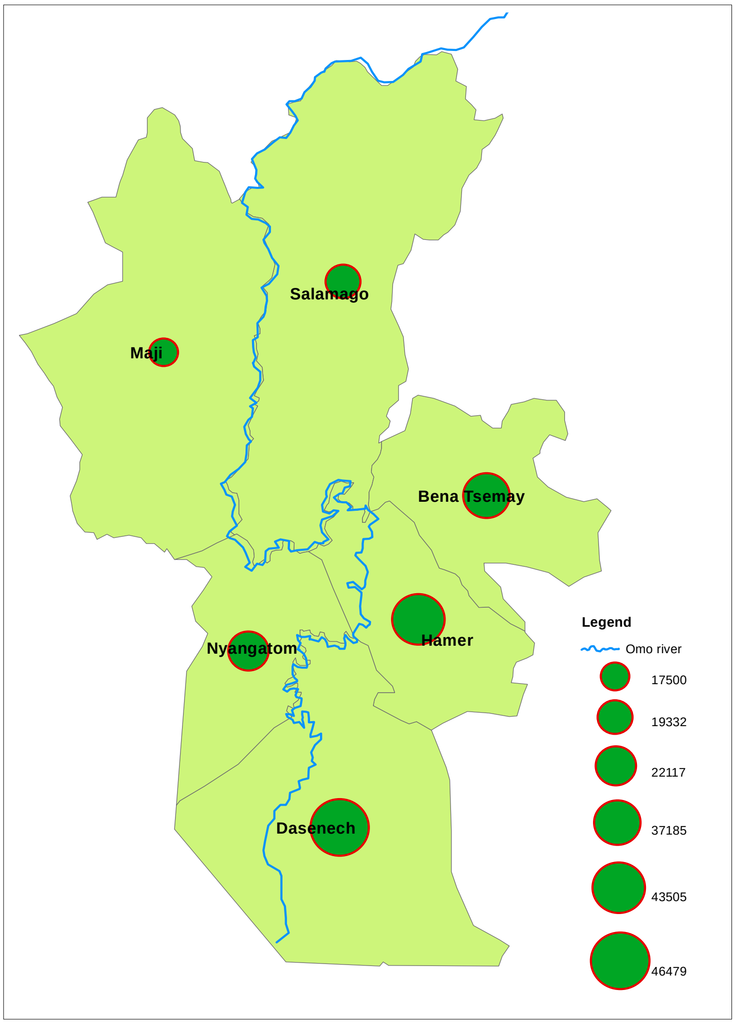


Figure 3.18: Weredas' population density

As explained in the subsequent paragraphs, many areas are still in need of adequate education, health facilities and marketing infrastructures, an essential element for pastoral livelihoods.

Culture and tradition play a big role in the lives of local people in this area. Traditional governing systems which manage the environment, resources, community justice and social welfare do exist within each group, with the elders playing a major governing role.

The past few years however have seen an increasing erosion of traditional authority.

This is due in part to the increasing influence of the external world (in particular education, modern state systems and commercial ventures) on young members of the community, but also due to the increasing vulnerability of the pastoral livelihood.

3.3.2 Ethnic composition, religion and gender issues

The area is rich in both cultural diversity and natural resources. Its total population is estimated at nearly half a million in 2005 (Awoke 2007: 66) belonging to 16 original ethnic groups with widely different backgrounds.

Amongst these, a few are on the verge of disappearance and absorption by larger groups. The ethnic groups are Dasenech (Galeb), Nyangatom (Bume), Murile, Kara(Karo), Hamer, Banna, Arbore

(Hor), Birale (Ongota), Tsemako, Ari, Maale, Mursi, Bodi, Dime, Atse, and Kewegu (Bacha,Yidinit, Muguji).

The scope of this section is to describe the main features of the ethnic groups living in the Lower Omo Valley with special reference to those inhabiting Salamago, Hamer, Nyangatom and Dasenech Weredas.

Except the land of the Dasenech that is only inhabited by that particular ethnic group, more than two ethnic groups inhabit the other three Weredas. The Kara, Hamer and Arebore live in Hamer Wereda, whereas Mursi, Dime, Bodi and the northern section of Kewegu (Bacha) live in Salamago Wereda. The Nyangatom Wereda is inhabited by the Nyangatom, Murile and the southern section of Kewegu (Muguji).

The Mursi inhabit the area " ... *between latitudes 5 20'N and 5 8'N*" Turton (1973:1.) in the territory comprised between the Mago River and the Banna ethnic group on the east, the Omo River on the south and west, the Bodi (Me'en) and Ari on the north and northeast, respectively (Turton 1995:8; Awoke 2007:87).

Mursi speak the Surma language, which belongs to the Nilo-Saharan language sub-family (Bender and others 1976:15.).

This ethnic group, as an agro-pastoral people of the Lower Omo Valley, subsists both on livestock and agricultural products. They mainly raise cattle, sheep and goats. Crops are grown along the Omo riverbanks and in the bush belt, in which the latter is a type of rain-fed agriculture.

Main crops grown are varieties of *Liba* (sorghum), *Kono* (maize), *Oggo* (haricot beans), cowpeas, and squash. The tribe further engages in fishing, hunting and apiculture.

Pastures are mostly located in the Elma valley. Livestock is of crucial cultural, social, and economic importance. In addition, livestock is the source of status, prestige and wealth, besides its value as food at cattle camps and in the settlements.

The wealthiest Mursi has the right to marry more than five wives based on the amount of livestock he owns. Above all, cattle, sheep and goats are slaughtered and served during ritual ceremonies.

Agricultural activities are performed according to their own calendar, which is based on specific seasonal events. In other words, the calendar is formulated on the basis of the appearance of the new moon and of seasonal variations in the level of the Omo River.

In relation to this, Turton (1995:11) reported the: "The cycle of seasonal events and activities (bergu) is subdivided by counting the interval between one new moon and the next, beginning with the month in which the Omo reaches its maximum level."

The following is an illustration of their calendar adapted with minor changes from Turton:

Table 3.16: Mursi calendar and main events

No	Mursi season	English month	Activities
1	Telegai	August/September	Omo reaches maximum level; storage of rain –fed harvest
2	Loruwhy	September/October	Omo level recedes; preparation of plots for flood cultivation; burning of grass in Elma valley.
3	Loru	October/ November	Small rains; planting at Omo; cattle to Elma.
4	Su	November/December	Weeding at Omo
5	Su	December/January	Bird-Scaring at Omo; burning of rain-fed areas.
6	Su	January/February	Harvest at Omo; burning of rain –fed cultivation areas.
7	Su	February/ March	Storage of flood crop; women move to rain-fed cultivation areas.
8	Oiyoi	March/April	Planting of rain -fed crop; men move cattle back from Elma near rain – fed agriculture.
9	Oiyoi	April/ May	Weeding.
10	Oiyoi	May/June	Bird-scaring
11	Oiyoi	June/July	Harvesting
12	Telegai	July/August	Drying and threshing of rain-fed harvest

Source: Turton (1995: 12)

The settlement pattern of the Mursi is organized according to their lifestyle, namely pastoralism and agriculture. Mursi people are divided into three local groups known as *Dola*, *Ariholi* and *Gongulobibi***.** Members of each group have a permanent sphere of influence on specific areas for flood and rain-fed cultivation, areas where they intend to move and graze their livestock (Turton 1995:8.).

However, they have no permanent residence. They move from one locality to another depending on the seasonal activities they need to perform. For instance, women, girls and young children move and live for sometimes on the banks of Omo River and in areas of rain-fed cultivation at other times. Men and boys spend most of the year in cattle camps in the Elma valley.

During heavy rains, the groups of the Mursi come together for sometime and perform/celebrate several cultural and social events, including marriage. Then in the early dry season they again start to disperse in order to attend to their businesses.

The Mursi divide tasks and activities among men and women. All domestic activities including grinding grain, cooking, fetching water, firewood collection, child care and the like are strictly women's and girls' affairs. In addition, most agricultural activities at the Omo and in the rain-fed cultivation areas are primarily performed by women and girls, who are also responsible for building huts at the cultivation sites.

Men and boys are mainly engaged in activities relating to pastoralism. They follow their livestock and live in cattle camps except for a brief period at the time they converge and join women and girls at the rainfed agricultural sites. Besides grazing and watering the herds, men are responsible for defending their territory.

Elders have roles in religious, social and political matters. They are predominantly occupied in performing and leading ritual ceremonies.

Generally, there is gender disparity among the Mursi people. One of the disparities is clearly manifested in their popular culture of the leap and ear plate of the females and the *donga* contest of the male.

Donga is the biting competition by the Mursi youngsters commonly conducted after the harvest time. Donga contest is the expression of masculinity, while wearing leap plate is a sort of beautification used for the purpose of attracting male partners.

The Kara (meaning fish) is a small ethnic group inhabiting the east bank of the Omo River, within the Hamer Wereda. The Omo in the west, the Hamer in the east and the Banna in the northeast border these people. Linguistically, the Kara are speakers of the South-Omotic language, one of the dialects spoken by the Banna and Hamer (Bender and others 1976:59.).

The means of subsistence of these people are both cultivation on the Omo River banks and small stock herding. On the riverbanks they grow different crops among which *Isni* (sorghum), *Kormosho* (maize) and *Wahha* (beans), whereas small stock husbandry is based on sheep and goats. However, they supplement their livelihoods through fishing, hunting and apiculture.

Similar to the Mursi, the Kara conduct agricultural activities along the Omo riverbank based on their own calendar, which is divided into thirteen months. The Kara formulated their calendar based on the interval between the new moon (locally called *Arfi*) and the next, beginning from the month after the long dry season. The year is divided into two seasons: namely *Berji* (rainy season) and *Banna* (dry season).

The following is the Kara calendar with its English equivalent months and seasonal events / activities.

Table 3.17: Kara calendar and main events

No	Kara month	English month	Natural event and activities
1	Duka	March	Rain starts to fall
2	Puppa/Fatta	April	Rain continues to fall
3	Halet	May	Rain continues (until mid of the month)
4	Zekko	June	Omo starts to rise in level
5	Lannamura	June /July	variation in the Omo
6	Murra	July	Omo continue to rise
7	Mekko	August	Omo reaches maximum level; start to recede
8	Silda	September	Start to clear land and began to plant
9	Karkaro	October	Continue to plant grain
10	Terjjo	November	Start to give blossom
11	Kelkila	December	Start to ripe; scaring away birds and baboons
12	Barre	January	Grain ripen; began harvesting
13	Sorri	February	Thresh and transport to settlement

Source: Field note (November 2007)

The Kara live in three settlements with Kara-Dus being the largest, followed by Kara-Lebuk and Korocho.

Every married Kara has two houses, of which one (*Ono)* used for dwelling and the other (*Gappa*) as a place to perform different activities.

In the Kara-Dus settlement a common building locally known as *Marmar* or *Galma* was noticed, this being a sacred site to conduct a number of ritual ceremonies; for instance, rituals related to the rite of passage like the *Gorri* and *Bulla***,** and those performed to drive out diseases from the settlements are conducted in *marmar*.

There are various beliefs among the Kara and the most common is ancestral worship. They believe that the spirits of their ancestors exert influence on their daily activities.

They assume and believe that said spirits are important in protecting them from misfortunes of any kind.

The chiefs are known as *Arti* and are responsible to deal with matters such as the spread of epidemics, famine and other serious problematic issues.

There is a social allocation of roles for men and women among the Kara ethnic group. According to this arrangement all domestic activities include grinding grains, preparing all kinds of foods, fetching water, collecting firewood, and a number of other activities are mainly women's domain.

The women also perform most agricultural tasks, such as planting crops, weeding, scaring birds and baboons, harvesting and transporting the products.

Men are responsible for clearing fields prior to planting. Besides, they are responsible for looking after the smallstocks, taking them to pastureland, watering and keeping the stock safe against wild animals and raiders. They are also responsible to defend their territory from enemies.

The Dasenech, also known as ***Galeb*** live in the former Kuraz and the present Dasenech. They are bounded by Kenya and Lake Turkana on the south, the Sudan on the west, the Nyangatom on the northwest, the Hamer on the north and northeast (Awoke 2007:95).

The Dasenech are speakers of the Cushitic language, which belongs to the East Cushitic Sub-family (Bender and others 1976:59). These people are the third largest population in the South Omo Administrative Zone, after the Ari and Hamer ethnic groups (Awoke 2007:95).

Similar to the other people in the Lower Omo Valley the Dasenech are agro-pastoral people, basing their subsistence both on livestock products and riverbank cultivation. They raise cattle, sheep, goats and donkeys and engage in recession agriculture. Fishing and hunting are also important activities in supplementing their livelihood.

Similar to the Mursi and Kara ethnic groups, the Dasenech formulate their own calendar which is divided into twelve months starting from the month when the Omo River reaches its maximum level. Each month has nearly 30 days.

The following table shows the calendar with local names, the English equivalent months and some of the major agricultural activities.

Table 3.18: Dasenech calendar and main events

No	Dasenech month	English month	Activities
1	Garmer	September	Omo starts to recede; grain planting begins
2	Sanoch	October	Weeding at Omo (mid of the month)
3	Kuwoch	November	Starts to blossom
4	Guwe	December	Starts to ripe; Scaring birds
5	Hele	January	Harvesting and transporting
6	Warle	February	Cultural and social activities
7	Warle	March	As above
8	Warle	April	
9	Chaar	May	
10	Sirnanu	June	
11	Chade	July	
12	Warle	August	

Source: Field note (November 2007)

Dasenech are divided into eight clans or tribal sections known as Inkabelo, Narich, Rendele, Elele, Oro, Koro, Rele and Inkoria. Except the Koro and Oro, the six clans have their own territory with varying population figures.

The Inkabelo clan, which inhabits both the east and west banks of the Omo River, represents the majority of the population. The Inkabelo territory is rich both in grazing and arable lands. The Inkoria and Narich live mainly on the east bank of the Omo.

The other three clans, namely the Randele, Elele and Rele still inhabit the east, while Koro and Oro have no territory of their own and live among the Inkabelo's (Almagor 99-100).

The western bank of the Omo with higher concentration of villages is more habitable than the east bank. The population sizes in each settlement, including the riverine villages, vary from one season to another.

During the heavy rains period, people return to the settlement and more people are found in each village. Again early in the dry-season, people start to leave their settlements, men to the pastureland, women to the world of cultivation.

Carr (1977:206) summarized the Dasenech settlement as follows: “It is important to point out that the mobility of a village is not necessarily predictable on the basis of whether it is located in one of the densely populated settlement areas or one of the thinly settled regions. All settlement areas for instance, include some villages that remain for only a short time and there are a number of rather isolated villages which have moved only very short distances for many seasons or even years. Generally plains villages are relatively stable in location.”

Gender roles arise from socially constructed differences between men and women, which define their roles: how men and women should think, act and feel. Therefore, there is a strict gender division of labour among the Dasenech.

According to the gender-based division of labour, women are entrusted with multiple roles and tasks. Women and girls are responsible for all domestic work such as grinding grains, preparation of food, collection of firewood, fetching water, looking after the children and the like.

Women are also responsible for milking the goats and cows and for constructing huts. Women, including girls, do most of the agricultural activities.

On the other hand, the Dasenech young men and boys are entrusted with tasks related to caring livestock that includes grazing, watering and guarding against attacks from wild animals and human raiders.

The elders are responsible for leading ritual ceremonies. Besides, they are the ones to negotiate social conflicts at the settlements. Almost throughout the year, the elders are present at villages.

The Bodi call themselves *Me'en*. They are a group of people living with the Mursi and Dime ethnic groups in the Salamago Wereda of South Omo Administrative Zone. Geographically, they are located east of the Omo River although there is another group of people known as Me'en (Tishana) inhabiting the opposite bank of the Omo River.

The Bodi and the Tishana are linguistically and culturally similar. Besides, the two groups often intermarry. The Bodi are bordered by the Mursi on the south, by the Dime on the east and the Omo River on the north and west.

Linguistically they speak the Surma linguistic family of the Nilo-Saharan (Bender and others 1976:59). They call their language "Me'enin". Fukui (1979:149) estimated the Bodi population at about 3000.

The Bodi are agro-pastoralists living on the products of their livestock and the cultivation of riverbank and the bush belt. They keep their livestock in the central grassland of their territory.

The Bodi are divided into two major sections. These are the *Mela* and *Chirim*. The former inhabited the southern, while the latter inhabited the northern, sections of Bodiland. Their settlement areas include Gio, Omo Hana, Gora, Oso, Bacha and Omo Rambe.

They have two types of houses. The first is the house in the settlements. The second house, known as Mulla is a type of house they built near the Omo River during the dry season and serves the women as a living room during the cultivation period.

Gender roles are highly differentiated in the activities that men and women perform. The women attend to domestic activities such as grinding grain, preparation of foods, fetching water, collection of firewood, looking after the children and the like. Women and girls are also responsible for performing most of the agricultural tasks such as planting, weeding, scaring birds and wild animals, harvesting and transporting of grain.

On the other hand, men and boys are responsible to look after the herds, and to defend their territory against any attacks.

The Nyangatom or ***Bume*** inhabit Nyangatom Wereda. Kangaton, the seat of the Wereda administration, located on the shore of the Omo River. They are bordered by the Mursi on the northeast, by the Kewegu (Yidinit), the Kara and the Omo River on the east, the Surma on the north, the Dasenech on the southeast, Kenya and Lake Turkana on the south and the Sudan on the west (Awoke 2007:71).

The Nyangatom are speakers of the east Nilo-Saharan language (Bender and others 1976:59).

They perform recession agriculture and livestock keeping, cultivating crops both along the Omo and Kibish Rivers such as sorghum, maize and beans both on the riverbanks and in the flood plains.

Cattle, sheep, goats and donkeys make up their livestock. In addition, they supplement their livelihoods with hunting and beehives.

The Nyangatom inhabit areas along the Omo and Kibish Rivers and the Savannah. It was reported that "--- One group lives along the Omo River, and mainly cultivates crops on the riverbanks and in the flood plains ---. The other group lives in the savannah to the west of the Omo River, and mainly raises livestock (Hieda 1996:148.)

The Nyangatom have division of labour based on gender. All domestic tasks including grinding grain, preparation of foods, fetching water and collection of firewood, looking after the children, milking cows at the settlements are the exclusive domain of the women.

Moreover, most of the agricultural activities, except land clearance, are predominantly performed by women and girls. House construction is also the task of women.

Men are predominantly responsible to look after the livestock for tasks such as grazing, watering and protecting against attacks from wild animals and raiders. The elders are commonly entrusted with tasks related to ritual ceremonies. Negotiating social disputes among the community members is also the responsibility of elders.

The Murle (***Murule***) are a small group of people living in the Nyangatom Wereda. Their history is obscure; according to their legendary story, however, they came from the border of Kenya and the Sudan, from a place called *Kottien.*

After they crossed into the Lower Omo Valley, first they settled east of the Omo River, south of Lake Dipa and north of a locality known as Shungura. Following the invasion by the Kara and the loss of dozens of souls in the early 1970s, the Murle deserted the eastern settlement and crossed to the west of the riverbank, got refuge from the Nyangatom and established themselves at Aiba village (Streker 1976:15.)

Linguistically, the Murle are speakers of the Surmic language of the Nilo-Saharan sub-family (Bender and others 1976:59.) Currently, only a few elders of the Murle use their original language, while most members of the new generation speak Nyangatom.

This fact was reported by Hieda (1996:159) as follows: "*Due to the complete shift to Nyangatom, only nine elderly members of the Omo Murle still speak the Omo-Murle language*".

The Murle subsist by a combination of subsistence means. Sorghum cultivation on the riverbank, hunting and gathering of wild foods and collection of honey are important activities for the Murle. Besides, they keep a small number of goats, sheep and chicken.

Aiba is the largest settlement area of the Murle ethnic group. They live in settlements like Murle and Kaka Kataba.

Among the Murle, like other local traditional people, females and males have different roles assigned. Childcare, preparation of foods, fetching water and collection of fuel wood are primarily done by females. Besides, they are responsible for most of the agricultural activities. Hunting, collection of forest honey, performance of rituals are predominantly the occupation of men.

The Kewegu are a small group of people living in the Lower Omo Valley. Despite they call themselves Kewegu, they are known by different names among different localities in the region. In fact they are known as "Bacha" "Muguji" and "Yidinit or Idini" by the neighbouring agro-pastoral and agricultural people.

Linguistically, the Kewegu are speakers of the Surmic language, which belongs to the Nilo-Saharan super family (Bender and others 1976:59).

They are riverine dwellers who subsist on riverbank and flood plain cultivation. They are also experts in hunting and fishing.

They supplement their livelihoods with collection of forest honey, and wild foods and keeping a few sheep and goats.

The Kewegu living north of the Kara are known as the Muguji and, those in the village are called Kuchur. Before the establishment of this village, which is located west of the Omo, they had lived scattered along the banks of the Omo River, in small groups.

The rest of the Kewegu (Muguji) live with the Kara mainly at Lebuk and Dus intermingling themselves with the Kara.

In the Bodi territory, they live intermingled with the Bodi. Currently, Kuchur is their permanent village near to Omo River. Further, all the other settlements are located near the river Omo.

The Kewegu men and women have different roles to accomplish. Hunting, collecting forest honey and fishing are primarily performed by men. Clearing and burning bushes and canoe making are exclusively the occupation of the men.

The women usually engage in all domestic works and agricultural activities including, planting, weeding, scaring birds and baboons, harvesting and transporting.

3.3.3 Conflicts and sources of conflict in the Lower Omo Valley

Most of the recent past history of the Lower Omo valley is characterized by inter ethnic conflict. Each of the major ethnic groups such as the Bodi, Mursi, Nyangatom, Dasenech, Hamer, and to some extent, the Kara, were in conflict with their neighbours for a long period of time in the past.

Causes of the conflicts were multiple and different. According to informants from each ethnic group the following are the major causes of the inter-ethnic conflicts in the Lower Omo Valley:

Competition for control of the scarce grazing and water resources, especially during the dry- season. For instance, grazing areas around Chelbi or Lake Stephanie are causes of conflict between Hamer and Erbore, Dasenech and Borana. Dry season grazing land near the Mago also is a cause of conflict between Hamer and Mursi. Besides, the Dasenech clash with Turkana when the former leave the Delta for dry season grazing near the Ethio-Kenyan border.

The second most important cause of conflict is related to raiding and counter-raiding of cattle and small stocks and killings of each other as a result of the raiding. This was for instance common in the past amongst Hamer, Mursi, Banna, Toposa, Nyangatom, Dasenech, Turkana, and Gabra.

Killing of a member of another ethnic group for various cultural reasons was also another cause of conflict in recent past. For instance, male genital mutilation was reported as cause of conflict between the Hamer and the Borana.

Competitions over cultivable riverbanks and stealing of crops grown on the riverbank were also reported as causes of conflict between the neighbouring ethnic groups in the valley. The Kara and Nyangatom fought at various times to control cultivable riverbank at the west bank of the Omo River. Mursi and the Nyangatom have fought in the past for control of the crops produced along the Omo River. Also the Kara fought with the Kewegu ethnic group over the land along the river.

Currently there is a new cause of conflict over the fish resources of Lake Turkana between Kenyan fishermen and their Ethiopian counterparts, with loss of lives on both sides. Besides, stealing and counter stealing of fishnets have been reported as a daily occurrence between the two groups.

Another newly reported conflict concerns the Bodi and the newly settled Konso people with killing reported on both sides.

Several peace making initiatives have been made since 2002 in an effort to end conflicts among the ethnic groups in the Lower Omo valley and adjacent areas.

At present EPaRDA (Ethiopian Pastoralist, Research and Development Association), a non-governmental organization is in the lead in this field. In the ensuing organised conferences leading members of the ethnic groups including women, elders and youths were represented.

At the end of each conference agreements were reached to avoid further conflicts and committees were established to follow up and assure the agreement.

Such committees have been working in close cooperation with local officials and non-governmental organizations.

As a result of the peace making efforts, officials argued that initial positive results have already been achieved, with ethnic groups previously suspicious of each other now having started to graze and water their livestock side by side.

Besides, in order to normalize past grievances some of them started to arrange marriages between different ethnic groups.

3.3.4 Income and employment: Economic Analysis

3.3.4.1 Agriculture and labour

The agricultural economy in the Salamago, Nyangatom, Hamer and Dasenech Weredas is almost entirely at subsistence level, with the greater part of the population growing and consuming their own food production. Farmers are very careful to minimize risk.

This accounts for the marked reticence of most farmers to adopt new farming technologies and strategies that they may perceive to entail a degree of uncertainty, resulting from lack of skill, input or both.

The size of the peasant farms is generally very small (usually less than one hectare) and farms are often fragmented.

As shown in the following table, cereal-based mixed farming systems represent the most common type of system production within the Basin. They include a number of variations that reflect local agro-ecological conditions.

Maize is by far the major cereal in both areas cultivated and total production, largely displacing sorghum at medium and lower altitudes. However, in the semi-arid lowland Wereda of Mursi and Dasenech, sorghum becomes the dominant crop of planted area.

Table 3.19: Agricultural and livestock Production

Major Crop	Production (QT)	Land (ha)	Major Livestock	Size
Maize	578.013	39.310	Cattle	795.698
Sorghum	362.440	27.880	Goat	618.343
Taro (Godere)	120.482	1.506	Poultry	501.722
Potato	120.482	1.506	Sheep	413.565
Barley	77.736	6.478	Equines	71.957

Source: Field survey made by MDI Engineering and Agriconsulting Spa.

The agricultural production based on flood retreat comprises a great number of households in the concerned Wereda.

Thus, as the following table highlights, Dasenech and Nyangatom farmers could be the more affected target groups to potential environmental changes brought about by the project.

The number of households that produce crops and hold livestock which are dependent on mixed farming is considerable, and just as important is the number of households depend exclusively on livestock, mainly for Hamer breeders.

Table 3.20: Farming systems

Wereda	Flood retreat farming Number of households depending exclusively on flood recession farming	Lowland agro-pastoral farming Number of households depending on mixed farming: producing crops and holding livestock	Pastoral system Number of households depending exclusively on livestock	Highland agro-pastoral farming Number of households depending mainly on crop cultivation, animals are only used for traction and to cover own food and milk demand	Forest-oriented system Number of households depending almost exclusively on forestry and savannah	Average size of landholding per household (ha)
Salamago	1.800	1.800	1.800	1.595		0,75
Dasenech	7.899	15.799	26.332		2.633	0,5
Nyangatom	4.967					1
Hamer	2.172	4.325	3.712			1

Source: Field survey made by MDI Engineering and Agriconsulting Spa.

For what concerns agricultural labour, the peak labour period in the Wereda is concentrated within about four months: November for planting, December-January for weeding and February for harvesting. Due to the amount of work needed, households are often obliged to hire agricultural labour as shown in the following table.

Table 3.21: Using hired labour for selected farming operation (%)

Region	Zone	Wereda	Ploughing	Weeding	Harvest
SPNRS	South Omo	Salamago	100		
		Dasenech	65		35
		Nyangatom	90	10	
		Maji	3,4	96,6	
		Hamer	15,2	33,3	51,5

Source: Omo River Basin Development Master Plan Study: Final Report

3.3.4.2 Major constraints of crop production, food security and food aid

If we take a close look at the causes and effects of food insecurity in the Omo River downstream, it is possible to associate the causes with natural factors and the socio-economic base of the population.

Uneven distribution and erratic rainfall, floods, landslides, pest infestation, epidemic diseases of human and livestock are all considered natural factors.

On the other hand small land holding, population pressure, lack of draught oxen, less infrastructure and inadequate farm inputs are conceived under the second factor.

The findings of the field assessment as shown in the two following tables indicate that the magnitude of contribution of these factors to food insecurity varies from one Wereda to another.

The first table shows drought as one of the main causes of insecurity for the downstream river Wereda's farmers, as well as representing an important constraint to increase crop production as underlined in the second table.

Table 3.22: First main causes of crop losses in the field (%)

Region	Zone	Wereda	Drought	Rain/flood	Rodents	Wildlife	Insect	Disease	Weeds	Other
SPNRS	South Omo	Salamago	60		20	13,3	2,2	4,4		
		Dasenech	38,1		19	23,8	4,8	4,8	4,8	4,8
		Nyangatom	63,4	2,4		2,4	31,7			
		Maji	30,7	5,3	18,7	10,7	2,7	2,7	29,3	
		Hamer	59,1		2,3	18,2	4,5	15,9		

Table 3.23: First principal constraint to increasing crop production (%)

Region	Zone	Wereda	Oxen	Grazing	Feed	Seed	Labour	Fertilizer	Manure	Credit
SPNRS	South Omo	Salamago	10			8,9	15,6	9		
		Dasenech				13,6	13,6	4,5		3
		Nyangatom	64,3	2,4			2,4			
		Maji	49,3	4,1	5,5	5,5	4,1	1,4		1,4
		Hamer	65,1	7	4,7					

Source: Omo River Basin Development Master Plan Study: Final Report

3.3.4.3 Peasant associations and Cooperatives

Since the 1975 proclamation to provide for the Nationalization of rural lands, rural producers in Ethiopia were organized into Peasant Associations (PA).

Peasant associations are responsible for the maintenance of law and order and the implementation of government decrees in the rural areas.

All adult household heads are members of the peasant association of the area in which they reside, and are entitled to nominate members for election and vote in the elections for various peasant association committees.

Peasant associations are further empowered Service Cooperatives (SCs). Service Cooperatives are combinations of two or more peasant associations for the provision of basic economic services, such as production inputs, credit, consumer goods, and marketing services.

Once a peasant association becomes a member of a service cooperative, individual members of the association should pay a small registration and contribution fee in order to capitalize the service cooperative.

According to the information gathered during the field visit, in the South Omo Zone, the cooperatives' adherents are about 61,452 approximately located in all the Weredas, influenced by the Omo River economy.

There are three major types of cooperatives running at the moment in the downstream Omo (as shown in the following table): multi-purpose breeders, farmers and savings and credit cooperatives.

Table 3.24: Cooperatives' matrix about South Omo Zone

Wereda	Type of cooperatives	Quantity	Cooperatives members			Users	Female	Total
			Man	Female	Total	Man		
Debub Are	Farmers multipurpose	15	2.592	428	2.720	10.600	10.686	21.366
	Saving and credit	3	135	37	172	420	440	860
	Irrigation coop	1	25	0	25	62	63	125
Maji	Multi-purpose breeder	4	922	19	941	2350	2355	4705
	Saving and credit	1	22	0	22	50	60	110
	Beekeeping coop	4	95	2	97	265	220	485
Dasenech	Multi-purpose breeder coop	1	200	27	227	800	980	1780
	Irrigation coop	1	100	70	170	500	300	850
	Fishery coop	1	26	26	52	152	89	241
Hamer	Breeder- marketing coop	8	385	61	446	942	990	1932
	Multi-purpose breeder coop	4	636	281	917	1672	1978	3650
	Leathering coop	1	15	0	15	41	43	84
Bena Tamaye	Breeder- marketing coop	3	393	6	389	950	995	1945
Salamago	Breeder- marketing coop	4	1995	83	2078	5110	5280	10309
	Multi-purpose breeder coop	2	559	0	559	1380	1395	2795
Nyangatom	Breeder- marketing coop	1	60	0	60	180	170	350
Semen Ari	Farmers multipurpose breeder	8	1888	7	1895	4570	4905	9475
	Saving and credit	1	66	12	78	180	210	390
Total								61.452

Source: Field survey made by MDI Engineering and Agriconsulting Spa.

The Peasant Training Centre (PTC) is a representative of the support of the Ministry of Agriculture at Wereda level.

At the moment, field visit results and the Ministry of Agriculture data show that function only in Hamer Wereda. PTC is managed by the Wereda agricultural and rural development office and composed of sectoral experts in fields such as natural resources, plant science and animal health.

Table 3.25: Peasants Training Centre (PTC) per Wereda

Wereda	Peasants Training Centre (PTC)				Animal Health Clinic
	On construction	Constructed	On service	Trained peasants	
Salamago					1
Dasenech					4
Nyangatom	2	1			2
Hamer	3		7	24	5

Source: Field survey made by MDI Engineering and Agriconsulting Spa.

The previous table clearly shows how the services dedicated to support farmers and breeders are still weak and unorganized.

Livestock services in most parts of the Basin remain poor because of inadequate infrastructure, basic facilities and lack of appropriate manpower.

Extension Services in animal health are weak at field level. Extension Services in animal husbandry, and product handling, processing and marketing are also rudimentary.

3.3.4.4 Household income analysis

The majority of households in the South Omo Zone are primarily subsistence farming families with low cash incomes, usually derived from the sale of small quantities of cash crops or other agricultural products as shown in the table below.

Low-cash income household fluctuates according to some major limitations like recurrent drought and/or floods, insufficient technology development and dissemination, high population density in the fertile area, natural resources degradation.

Plots of maize and sorghum cultivated by household or family groups are small in size, usually around 0.3-0.5 ha, all of which are cultivated by hoe.

Major factors determining scale and success of crop production in this type of farming system are levels and amount of flooding of the riverbanks and the area that is inundated.

Table 3.26: First source of household cash income (%)

Wereda	Sale of cereals	Sale of seed	Sale of tubers	Veget-able	Sale of fruits	Sale of spices	Livest-ock	Hides and skins	Sale of milk	Sale of butter	Hire of oxen	Perma-nent crops	Other
Salamago	9,1	1		4,5	2		66,2						17,2
Dasenech							38,6		22,7	34,1		4,5	0,1
Nyangatom	2,4						7,1		33,3	35,7			4,8
Maji	5,4	2	3,2	14	3,1	2,4	5,3		2,3	3,7		32	26,6
Hamer				10,7			13,6	16,7	4,5	45,5	2,3		23,4

Source: Field survey made by MDI Engineering and Agriconsulting Spa.

Most domestic needs and equipment such as food, fuel wood, building materials, cooking pots, water containers, utensils, farm tools and some clothing are grown, cut, made and/or gathered locally without any cash transaction involved. Some items may be exchanged through barter.

Crop production for subsistence may be high, particularly in those parts of the basin where land pressure is not great and which have two good rainy seasons.

However, the annual cash income available to a farm household will usually be small. Such cash income will be used with caution to purchase clothes, tool heads (plow shares or axe heads amongst others), manufactured cooking utensils, or medical care.

Education and health represent the higher expenditure in the household's income as shown in following graphics.

In any case, both household income and expenditure are highly variable, constantly being influenced by a permanent uncertainty of the revenues caused by chronic food insecurity that affects households.

Vulnerable households attempt to sustain through coping mechanisms such as obtaining cash/food from labor-intensive public work, gratuitous relief and transfer from other sources.

A wide range of local household coping strategies experienced in the food-unstable Wereda in case of an emergency situation are among the following:

- Leasing out agricultural land,
- Collecting and selling fuel wood,
- Feeding on roots and leaves which are not eaten under normal circumstances,
- Migration to urban centres,
- Selling household assets,
- Involvement in off-farm activities such as petty trading and handicraft, and
- Reducing consumption and dietary change.

Socio-economic infrastructures and services are vital to the livelihood and improvement of society as well as a means of stabilizing household food security.

The constraints in this regard are: less coverage of road networking, low access to health and educational facilities, inadequate market facilities and inadequate water supply schemes.

Most movement is on foot. Goods are carried to markets as head-loads or back-loads; purchases are carried home on foot. Transport of goods by pack animal is seen as expensive.

Traders buy some goods purchased at rural markets from farm households; examples are teff, spices, honey and fruit. Traders need to transport their purchases to a larger centre like Zone capital Jinka.

They operate within the cash economy and will seek the most cost-effective means of transporting goods to a large town.

Agricultural products are therefore frequently moved by pack donkey from rural markets to larger towns (Hana, Turmi, Omorate), along naturally created dry-season routes, which can be accessed by motorbikes and vehicles.

Another important issue to analyze in terms of household income analysis is how the household wealth is composed, in other words, which are the elements that increase the wealth of the family.

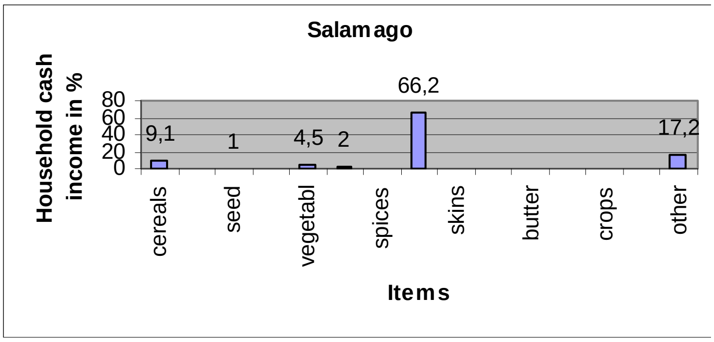
The schematics elements in the following table can generally represent an average division of the household into poor, middle class and rich. In each category the household' characteristics are mentioned which can usually determine its social status.

One of the main elements is the animal holding (especially cattle) and the land holding, usually more than 1-2 hectares to determine a good household income.

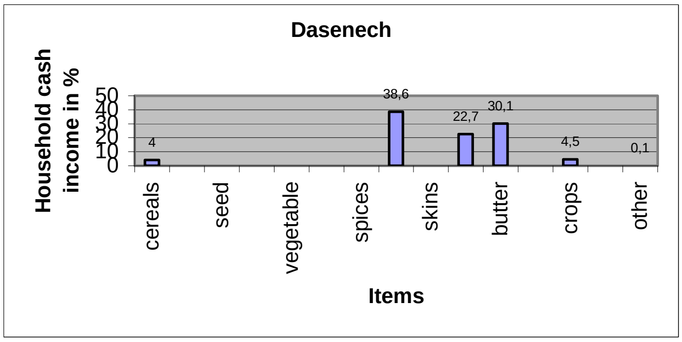
Diagram 1: Household income and expenditure

Salamago **Dasenech**

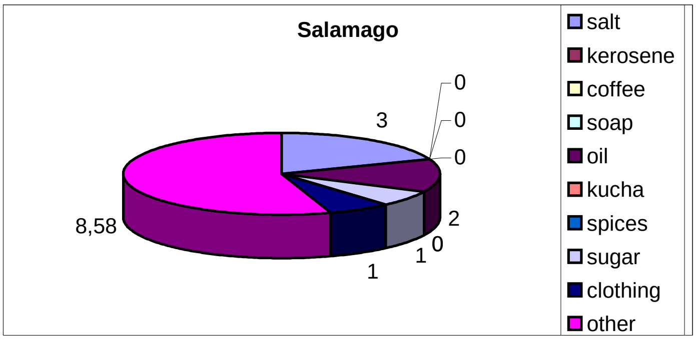
First source of household cash income (%)



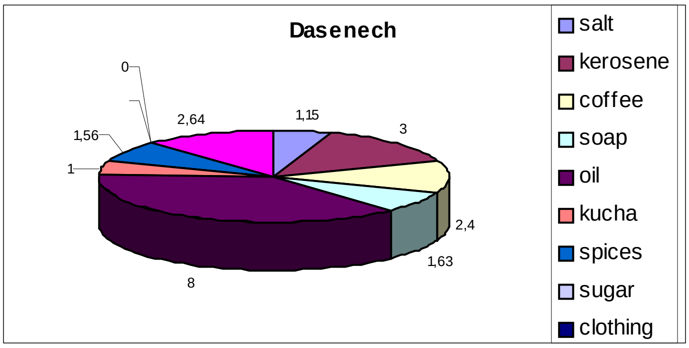
First source of household cash income (%)



Average weekly family expenditure on basic items (birr)



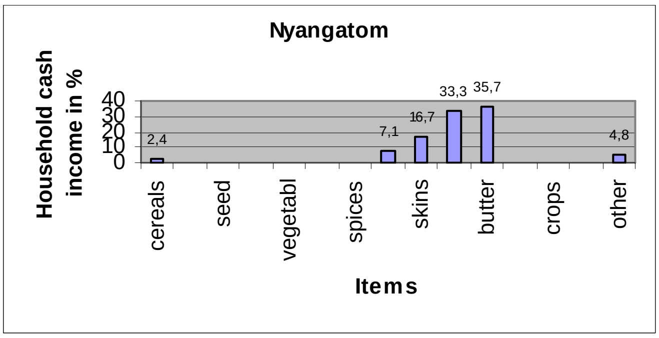
Average weekly family expenditure on basic items (birr)



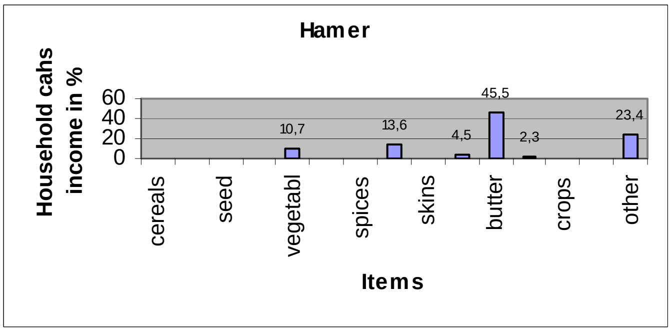
Source: Field survey made by MDI Engineering and Agriconsulting Spa.

Nyangatom **Hamer**

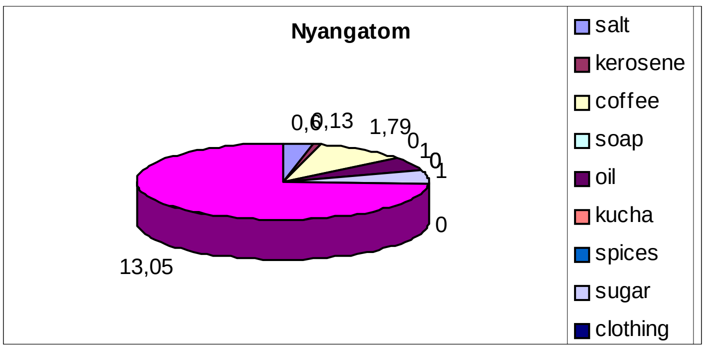
First source of household cash income (%)



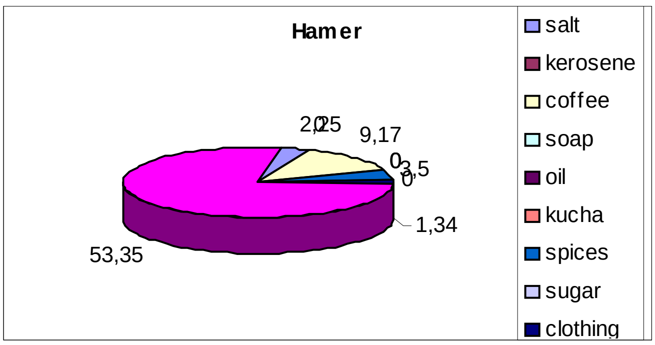
First source of household cash income (%)



Average weekly family expenditure on basic items (birr)



Average weekly family expenditure on basic items (birr)



Source: Field survey made by MDI Engineering and Agriconsulting Spa.

Table 3.27: Wealth group and characteristics

	Rich	Middle class	Poor
% Of Population (Aver. Estimates)	10 - 20%	20-30%	30 - 40%
Hh size	11 - 12 members, 2-3 wives, 1 to 2 of the family would be living away from t main household.	8-9 members, 2 wives In some households 1 or more member will be living/working away.	6 members, one wife. Some households may have one or more members living or working away.
Animal holding	Cattle**:** 300	Cattle: 100 + small ruminants and chickens	Cattle: 10 + small ruminants and chickens
Activities / income **Agriculture**	- Mainly sell livestock - Limited sales of livestock products - milk and butter; depends on proximity to market 1-2 (ha) cultivated	- Mainly sell livestock - Limited sales of livestock products, depends on proximity to market 1 (ha) cultivated	- Mainly sell livestock - Limited sales of livestock products - depends on proximity to market. 0,3-0,5 (ha) cultivated Yield: 4-6 quintals per year Consume: 3-4 quintals per year
Labor employed	May hire 1 person for herding	None	None

3.3.4.5 Food Security Assistance

The need for carefully planned food assistance has been underscored in the present government's rural development strategy.

Notwithstanding sporadic and pocket areas of food supply shortfalls (drought), remarkable achievements have been made in narrowing the overall food gap from domestic production since the launching of the extension program.

There is therefore a tendency to switch from food aid towards cash to purchase food grains from domestic markets and augment the stocks of food security reserve in good periods. This will help create effective demand via stabilization of prices during years of bumper harvest (price decline) in surplus areas.

Data presented in the following table show the causes of food insecurity in the Weredas in two different years.

Table 3.28: Food Security during last two major droughts

	1997				1998			
	Lack of water and food		Emergency assistance		Lack of water and food		Emergency assistance	
Wereda	**Lack of water**	**Lack of food**	**Emergency water assistance**	**Emergency food assistance**	**Lack of water**	**Lack of food**	**Emergency water assistance**	**Emergency food assistance**
Salamago	1	1	1	4	2	1	1	4
Dasenech	1	3	3	4	1	3	3	4
Nyangatom	2	3	1	3	2	3	1	3
Hamer	2	3	1	3	1	2	1	3
Scoring: Lack of water and food: Score: 1=*No*, 2=*Somewhat*, 3=*Severe.* Emergency Assistance Score: 1=None, 2=Sporadic, 3=Adequate, 4= Plenty								

Source: Field survey made by MDI Engineering and Agriconsulting Spa.

Following endorsement of the first version of the Food Security Strategy in 1996, efforts have been made to implement the strategy at a field level.

On the basis of these indications, Regional States, including SNNPR have prepared their Food Security Programs which were subsequently consolidated at a federal level and submitted to donors for co-funding.

This program has identified some insecure food districts (Wereda). It is an integrated program, which calls for interventions in agriculture, sustainable use of natural resources and management, infrastructure (rural roads), education, health facilities, rural credit and institutional capacity building.

Picture 14: Food aid distribution in Nyangatom Wereda Kangaten

Regional food security offices shall play a significant role in the co-coordinating of the program in their respective regions.

Wereda and *Kebele* development committees will be the lowest government institutions in facilitating the implementation. Of course, the community or the household will be the target of the project, as its performance will be measured in terms of desirable changes brought about in the livelihood of the people.

There will be a two-way exchange of information on a regular basis both upward and downward. Such flow of information will ensure the smooth implementation of the project in accordance with National objectives.

3.3.5 Agriculture

3.3.5.1 Rainfed agriculture

Rainfed cropping takes place at higher altitudes, where rainfall is higher and more reliable, and will therefore not be directly concerned with the present study.

However, most of the families in the study Weredas who practice some rainfed cropping, actually rely more on flood recession crops and livestock for their subsistence than they do on rainfed crops and the potential loss of recession crop area as well as the loss of grazing, should planned mitigation actions not properly be carried out, could make the contribution of rainfed agriculture to household economies more important in future.

Rainfed crops are cultivated in three out of the four Weredas where flood recession cropping is important; Hamer, Salamago and Nyangatom, at higher altitudes towards the west and eastern margins of the valley. Rainfall at lower altitudes, e.g. in Dasenech Wereda, is insufficient to support any rainfed cropping.

Areas of rainfed cropping, provided by the Wereda authorities are shown in the table below:

Table 3.29: Estimated Areas under Rainfed Agriculture at Present

Wereda	Hamer	Salamago	Nyangatom	Dasenech	Total
Rainfed cropping (ha)	9,271	7,940	500	0	17,711

Source: Wereda officials by questionnaire

The first rains come in March/early April and the main planting month for rainfed crops is April. The growing season is only 2-3 months and harvest takes place in June and July, before the onset of the "short" rains in September/October.

A single crop per year is possible, with short duration varieties only. As usual, where rainfall is limited, it is also unreliable and there is always a risk of drought.

The second rains merely last a month, insufficient for a second crop. However a ratoon crop from the stubble of previous crops, particularly sorghum, may benefit from the second rains and provide some forage for livestock.

Rainfed cropping systems can be broadly identified as: (1). Maize dominated mixed cropping at the middle to higher altitudes, (2). Sorghum dominated mixed cropping at lower altitudes and (3). Small-scale riverbank mixed cropping, also at lower altitudes.

Labour for hoe cultivation and weeding is the main input, and is generally said to be in short supply due to the demands of livestock herding, low population levels and poor general health.

Oxen are very rarely used, partly due to cultural objections and also because of losses to disease. These factors all tend to limit the size of the cultivated area. No fertiliser use is recorded and, in any case could be a wasted expense in view of the erratic rainfall. Farmers use their own seed of traditional, locally adapted short duration crop varieties.

Livestock dominate the farming systems in all Weredas, although less so for the Hamer which are said to be 40% pastoralist and 60% agricultural in terms of subsistence dependency.

In the other three Weredas, crop products only provide food for 3-6 months of the year and most of that is from post-flood recession cropping, rather than dryland crops.

Blood, milk, butter, fish and food aid cereals make up the rest of the diet for the majority.

Crop production is an important source of forage, in the form of crop by-products such as maize and sorghum stalks, as well as grazing on field residues.

Pastoralists move animals to the plains during the dry months, except for milking cows and calves, to take advantage of the grazing made possible by the annual flooding of the river. They move back when the rains start and the risk of tsetse-fly borne trypanosomiasis increases in the riverine forests.

At the higher elevations, 900-1200 m a.s.l., where the Hamer people grow most of their rainfed crops, the soils are often eroded, sandy and stony, with low nutrient value. Slopes are frequently too steep for cultivation.

The questionnaire has produced an average sized cropped area per family of 1.5 ha for Hamer and 2.1 ha for Salamago, the Wereda with almost all rainfed crops in the four Weredas.

The main crops grown are maize, sorghum, haricot beans, cowpeas, tobacco and occasionally pumpkins. Inter-cropping is the norm and low plant populations, due to wide plant spacing, reflect the little amount of rainfall expected.

Local Agricultural Ministry officials gave an example of typical inter-cropping proportions in a sorghum dominated system as; 75% Sorghum, 15% Maize and 10% beans, tobacco etc., maize in this case being mainly consumed as green cobs because the growing season is too short to produce grain (75 days).

Under maize dominated farming at higher altitudes, where rainfall is better, the growing season is long enough to allow a maize grain crop to mature (100 days or so). With mixed cropping there is no place for crop rotation, but some shifting cultivation is reported where soil is so exhausted in one area that it has to be left fallow for some years and a new area planted.

No official figures were available for the yields of rainfed crops. Field observations indicated low plant populations of around 10,000 per ha. Based on typical proportions of crops grown together in the same plot, a hypothetical estimate of probable yields for the principal crops from one hectare of rainfed crops might be as follows:

Table 3.30: Estimated Yields of Mixed Cropping Rainfed

Crop	Proportion (mixed crop)	Yield (Q/ha)*	Actual Yield (Q/ha) (1 ha mixed crops)
Maize	75%	10.0	7.50
Sorghum	15%	5.0	0.75
Beans	10%	2.5	0.25

** based on a pure stand equivalent of 10,000 plants/ha on unfertilised, relatively poor soils, with traditional unimproved varieties.*

The above could be subject to losses from field and storage pests and diseases, which have been reported as between 20 and 40%. Even this rather low yield estimate may be optimistic in some areas. In addition to yields, when considering rainfed crop production, one has to take into account the likelihood of crop failure due to inadequate or poorly distributed rainfall.

The Master Plan Study suggests that crop failure can be expected at least one year in three. Basically the whole area is food insecure and famine relief is required in most years.

Table 3.31: Estimated Annual Production Rainfed Cropping

Crop	Area (ha)	Production (Q/ha)	Total Prod. (Quintals)	Total Prod. (Tonnes)
Maize	17,700	7.50	132,750	13,275
Sorghum	17,700	0.75	13,275	1,328
Beans	17,700	0.25	4,425	443
Total				**15,046**

**based on mixed cropping*

The estimated total production of the major food crops is therefore of about 15,000 tonnes. The questionnaire indicated that the number of households in the three Weredas which practice some rainfed cropping (Hamer, Nyangatom and Salamago) is 18,500 and it also suggests that about 50% of those are engaged in rainfed cropping (9,250 households).

This will therefore give each of those households an average production of 1,620 kg per annum.

There are usually weekly markets at the main Wereda settlements, but mainly for consumer goods and trading in small ruminants, poultry etc. There is little surplus grain produced for sale.

Government agricultural extension specialists, farmer training centres and demonstration plots are based at Wereda headquarters with Development Agents at the Kebeles. Shortage of transport and equipment for extension specialists and Development Agents is a major constraint on their effectiveness.

Some NGOs are providing improved seed of short duration crops (maize particularly) and trying to encourage some crop diversification (e.g. with pigeon peas). NGOs active in South Omo include Farm Africa, PACT, EPARDA and the Catholic Church.

Activities tend to be mainly aimed at supporting the livestock sector and include; animal health services, range management, establishing livestock markets, provision of a few sheep and goats to the poorest households who have no livestock, and establishing “resource areas” to extend grazing by creating watering places and mineral licks.

Some of the factors limiting rainfed crop production are summarised as follows:

Low and unreliable rainfall: Low rainfall results in a short growing season which limits the choice of crop varieties, to those which have a lower yield potential. It also restricts the farmer to growing one crop per year. Where rainfall is low it is also likely to be unreliable and unevenly distributed during the growing season, resulting in regular crop failures.

Shortage of good soils: Higher altitude areas where rainfed cropping is practiced are mostly hilly and eroded and the amount of good arable land is limited.

Shortage of labour: Labour shortage limits the area that can be cultivated and livestock herding takes many of the men and boys away during the cropping season. Compared to flood recession cropping, rainfed agriculture requires a lot more labour for land preparation, especially where oxen are seldom used.

*Low yield potential***:** Traditional varieties may have the advantage of being tried and tested but usually have a low yield potential. Improved short duration varieties could increase yields under the same conditions.

Limited crop types: Reliance on relatively few crop types, especially maize which is not very tolerant of drought, is a poor insurance against losses from drought or disease etc. and there is a need to promote crop diversification.

*Crop losses to pests***:** Bird damage to the sorghum crop and high post-harvest losses due to insect pests in storage, also reduce crop production.

3.3.5.2 Flood recession agriculture and river delta cultivations

The Omo River and its affluents rise during the rainy season and overflow their low flows banks to flood the land bordering the river are usually steep, with areas of recession crops grown on riverbanks often about 30-50 m large and some hundreds of meters long. These strips have been surveyed from satellite maps and illustrated in the enclosed plans as “recession agriculture” areas.

In the Omo river delta, during the rainy season, the increase in Lake Turkana water level replenishes moisture to soils allowing some permanent cultivation areas. These areas, totalling about 5000-7000 ha, are indicated in the mapping as “cultivation” zones.

When a large flood occurs on the Omo River (i.e. 2006 floods) such cultivated areas are partially flooded often with disastrous consequences.

In some parts of Nyangatom Wereda, in years of high flood, the river overflows to flood low lying marshy areas which are cropped after drying out. The fringes of the ox-bow Lake Dipa (Dipa Hayk) in the Kara area of Hamer Wereda are also planted as the lake level drops.

Peak flooding normally occurs between August and September and the water recedes 2-3 weeks later to allow planting from September to October.

The principal tribal groups which practice flood recession and cropping in the delta are the Dasenech, Karo, Hamer, Mursi, Murle, Mugugi and Nyangatom. Wereda officials reported that for most people, the grain produced from these cultivations was only sufficient for 3 - 6 months. Thereafter, they depend on food aid from the government and NGOs.

However, in a good year, people like the Kara, who are 100% agricultural, having no cattle because of the prevalence of tsetse fly on the river banks where they live, can be self-sufficient and perhaps even produce a surplus which they may exchange for sheep and goats from the Hamer.

Flood recession and riverine delta cropping is important in all four Weredas; Hamer, Salamago, Nyangatom, and Dasenech, from the Omo River, roughly between latitudes 4.45ºN to 6.00ºN from the latitude of Hana (HQ of Salamago Wereda) to Lake Turkana, some 200 km in a straight line, and more than double that distance in terms of the river length.

Extensive riverine delta cultivation, as opposed to limited river bank cropping, starts as the topography levels out, nearby Lake Turkana.

Most recession cropping in Salamago Wereda is along riverbanks, since there are no extensive areas of flat land, as found further south. Most cropping takes place from Ayloha village southwards.

In Hamer Wereda the main area of recession cultivation is found around Kara Korocho and Lake Dipa (Dipa Hayk), practiced by the Kara people.

In Nyangatom Wereda flood recession cropping predominates southwards of Kangaten, the Wereda H.Q., and in low lying marshy areas, further from the river, which flood in years of particularly high floods. Dasenech Wereda has the largest area of cultivation, mainly south of Omorate, where crops are being grown in the islands of the Omo river delta. Cultivation on this very flat plain can extend several kilometres either side of the river, and nearby the lake shores.

The following table shows the areas estimated to be under flood recession agriculture and delta cultivation at present:

Table 3.32: Estimated Areas and Households under Flood Recession and delta Agriculture

	Hamer	Salamago	Nyangatom	Dasenech	Total
Recession cropping from Omo River (ha) /1.	868	1170	2203	7650	11,891 ha
Average area cropped per household (ha) /1.	0.4	0.75	1.0	0.5	
Households engaged In recession cropping from Omo River /2.	2,170	1,560	2,203	15,300	21,233 h/h

/1. Source: Wereda questionnaire
Note: flood recession cultivation from other rivers is also practiced in all Weredas except Dasenech

In the Hamer, Salamago, and Nyangatom Weredas these areas are basically made up of flood recession whereas in Dasenech the riverine delta cultivations represent the large majority (about 5000-7000 ha).

The growing season for recession crops is dictated by the timing of the annual floods rather than rainfall, even if the “small rains” during the months of November and December (about 50-70 mm/month) may contribute to the crops growth during the low flows periods.

The floods peak between August and September, receding after 2-3 weeks or so to allow planting from September to October. The growing season is only 2-3 months and harvest of the main grain sorghum crop takes place from November to January, with green maize harvested earlier than sorghum.

Maize left to mature at lower altitudes tends to suffer from depleted soil moisture and high temperatures, producing small-shrivelled cobs as a result.

There are basically two cropping systems. (1). Large scale, sorghum dominated cropping on the flat plains to the south (i.e. river delta), and (2). Small-scale river bank mixed cropping, also in the same areas as well as further upstream where the valley sides are too steep for large scale flooding.

On the level plains cultivation of the soil is not necessary before planting, “zero tillage” in effect, while deposits of larger floods sediments allow adequate fertility on the land, which obviates the need for fertiliser. On river banks fertility is generally lower.

Seed of sorghum is soaked prior to planting, partly to speed up germination and emergence, since the soil surface dries out quickly under the hot sun and also to give the crop a head start on weeds. Post-emergence cultivation is done with hand hoes, mainly to kill weeds, but it is also important to create a loose dry soil mulch to minimise moisture loss by capillary movement from the soil.

Bird scaring is a major task in the sorghum fields, with children or adults standing on top of platforms in the fields.

Most of the ethnic groups who practice some recession cropping are primarily nomadic pastoralists. Exceptions include the Kara people, who live permanently near the river where the danger of tsetse fly and trypanosomiasis makes cattle keeping impossible, and the Hamer, who mainly occupy the higher land to the east of the plain, are said to be 40% pastoralist and 60% agricultural.

Livestock stay on higher ground during the flood season, returning to the plains after the floods recede. They need to be near the river for water but well away from the cropped areas. They eventually come back after harvest to graze on the crop residues and any ratoon growth, in the fields.

On the flat plains the area cultivated by each household is reported to average 0.4 - 1.0 ha, but the range will undoubtedly be much wider, depending on the area of suitable land, as well as such factors as availability of seed and the amount of labour the family can provide.

The Mursi and Bodi peoples in Salamago Wereda mainly practice river bank cultivation on the Omo and its tributaries on the edge of the riverine forest where soils are more fertile. Farms consist of small scattered patches according to the topography, reportedly totalling around 0.1- 0.2 ha per family.

Families may also plant sorghum and maize in dry river beds, after the flow has dried up, and here plots may be larger, around 0.5ha.

Given the labour constraints, this would seem to be a lot for one family, but as with flood recession cultivation, this is basically a “zero-tillage” system, because the flood has destroyed the weeds and the silt is soft and deep. Little if any hard labour on land preparation is required before planting.

The limited amount of water retained in the soil after annual flooding and lake level increases means a relatively short growing season of 2-3 months, which limits the range of crop species that can be grown, as well as restricting the choice of crop varieties to shorter duration, early maturing types, which have a lower yield potential.

Sorghum is the main cereal crop, being much more drought tolerant than maize, the latter being mainly consumed as green cobs because the growing season is too short to produce a good grain crop, particularly at the lower altitudes to the south.

Haricot beans, cowpeas, tobacco and pumpkins are also grown, more particularly on the river banks, leaving the all important sorghum crop to maximise production from the more fertile plains.

Inter-cropping is said to be the norm according to Agricultural Ministry officials, who gave an example of typical inter-cropping proportions in sorghum dominated system as 75% Sorghum, 15% Maize and 10% beans.

Seed is retained from one year to the next. Varieties are traditional, locally adapted types and the crops of white grained sorghum observed growing on the Dasenech plain looked promising, with a yield potential of 10.0 Q/ha or thereabouts. Stems were around 2-3 m long and there was no sign of nutrient deficiency.

Hardier, more bird resistant, red-grained sorghums were observed in the riverbank areas further upstream, reflecting the poorer fertility and soil moisture conditions. A yield of no more than 2.0 Q/ha (pure stand equivalent) for the sorghum crop would probably be optimistic there.

It would seem reasonable to assume an average output of sorghum from both the plains and the riverbanks, at around 6 Q/ha. Allowing for post harvest losses of 10-20%, the eventual yield of sorghum will be some than 5 Q/ha.

A fully mature maize crop, of a traditional unimproved variety under the same conditions could be expected to produce around 15.0 Q/ha of dry grain. Since it appears that most of the maize is consumed as green cobs, because of the short growing season, a yield of 3 Q/ha in dry grain equivalent has been assumed for the purpose of calculating crop production.

The table below gives an estimate of the yields from a hectare of mixed crop grown under flood recession and river delta agriculture.

Table 3.33: Estimated Yields of Mixed Cropping under Flood Recession / delta cultivation

Crop	Proportion (mixed crop)	Yield (Q/ha)*	Actual Yield (Q/ha) (1ha of mixed crops)
Sorghum	75%	5.0	5.0
Maize	15%	3.0 **	0.45
Beans	10%	2.0	0.20

* *Pure stand equivalent based on 40,000 plants/ha with, unimproved varieties under marginal conditions.*

** *Matured grain equivalent from green cobs.*

Taking the cropped area to be around 12,000 ha, food production will be some 5,000 tonnes annually. With 20,000 households (100,000 people) this would provide 250 kg of food per household per year, which in theory would be enough for a family of five for about 6 months (200-300gm/person/day).

The Mission was told that in many areas the sorghum supply normally runs out after only 3-4 months, but this could probably be explained by some allowance for wastage, sale, or feeding relatives etc.

The calculation for estimated annual crop production is presented in the following table:

Table 3.34: Estimated Annual Production Flood Recession and delta agriculture

Crop	Area (ha)	Yield* (Q/ha)	Production (Quintals)	Production (tonnes)
Sorghum	12,000	3.75	45,000	4,500
Maize	12,000	0.30	3,600	360
Beans	12,000	0.20	2,400	240

* *yield/ha based on mixed cropping*

After the main harvest, a second small harvest from the re-growth of sorghum (ratooning) in the delta area may be taken before livestock are allowed in to graze on the crop residues.

In the recession cropping areas there is generally no surplus grain to sell. There is some trading in small ruminants – goats and sheep from the Hamer uplands, sometimes in exchange for grain when the recession crop has been good.

A livestock market in Omorate, recently established with the aid of Farm Africa, is said to be attracting traders who buy cattle and other stock for sale in the highland urban areas, so perhaps the traditional objections to selling cattle are easing.

Factors limiting delta cultivation and recession crop production can be summarised as follows:

Unreliable floods: The annual river floods may be excessive is some years, causing human and livestock losses and too little at other times, limiting the area of crops that can be planted.

Short growing season: The amount of water retained in the soil is usually only enough for a growing season of 2-3 months, which limits the choice of crops and varieties, to early maturing types, which have a lower yield potential. It also restricts the farmer to growing one crop per year.

Low Yields: Sorghum dominates the cropping pattern in recession farming, mainly because of its drought tolerance and its ability to produce a mature grain crop with a short growing season. However the yield potential is 30 to 40% of the better maize varieties, which could be grown if sufficient water was available for a longer period.

Crop losses to pests: Bird damage to the sorghum crop and high post-harvest losses to insect pests in storage, also reduce crop production. The white seeded sorghum which is favoured by the people on the fertile plains is not bitter like the red sorghum and more palatable to birds as well as humans. Storing sorghum heads on platforms, in grass-wrapped bundles provides no protection against insects like weevil. The Mission observed severe damage in such stores.

3.3.5.3 Irrigated agriculture

Irrigation farms and schemes are found mainly in the lower reaches of the Omo River, because the banks of the river upstream are generally too high to permit efficient pumping.

According to the Omo-Gibe River Basin Development Master Plan Study of 1995, there are 1,350 ha under irrigation in the Weredas of Hamer and Dasenech, although the Mission only found evidence of 150-200 ha in operation.

Most are small farms growing high value crops like vegetables and fruits, particularly bananas, using either diesel pumps or windmills to extract water from the river. There are also a few small, state-owned demonstration and training farms with supervised tenant plots.

There are no large commercial irrigated farms but the (defunct) 10,000 ha State Farm near Omorate (Omo Higher Farm), which was established by the “Ethio-Korea Joint Agricultural Development Venture Project” some years ago to grow cotton, has recently been acquired by some investors and is apparently being developed to grow oil palm.

Overall, as will be seen from the following notes, the present level of irrigation development is really quite minimal for a number of reasons including damage caused by annual flooding, low river levels in the dry season (too low for pumping), limited market development, and the traditional, nomadic, pastoralist way of life of the people.

In Dasenech Wereda, windmills are popular for irrigating high value crops such as bananas and vegetables. They are the result of an NGO project and Wereda officials estimated that some 20-30ha is irrigated by windmills.
Many of these were seen from Delegnum Kebele, southwards through the delta, on the banks of the main river as well as the islands, although precise numbers were not available. Some are also used for grain milling, supplied under the same project.

The windmills are very simple in construction, even to the extent that the vanes are fixed and do not swivel with a change in wind direction, water is pumped by a vertical piston arrangement.

The discharge is very low, perhaps 1-2 lit/sec, depending on the level of the river and the water is led by furrows to the crops. Individual farm sizes are in the range of 0.25-0.75ha.

These farms are liable to flooding and can be under water for 4 weeks or so. Bananas take one year from planting to producing the first bunch and up to 15 bunches may be harvested from each planting station before replanting, 3-4 per year. They are currently selling at 20 Birr per bunch.

Dasenech Wereda officials estimate that there is 100ha of small-scale irrigation using portable diesel pumps and like the windmills they are situated on riverbanks throughout the delta area. They also produce mainly bananas as well as mangoes and vegetables.

Also in Dasenech Wereda, at Lobet 2 Kebele, there is a Ministry of Agriculture demonstration and training farm of 25ha supplied by a permanent 3-pump station on the Omo River. Demonstrations include the agro-forestry crops; *Leucaena leucocephala* and *Moringa oleifera*, as well as the pasture/forage grasses, *Panicum maximum* and *Chloris gayana* (Rhodes grass).

Irrigated plots of 0.25ha have been allocated to local farmers as training farms, where they grow 2 crops per year of maize, the first during January to March and the second during April to June. Vegetables are also grown.

In Nyangatom Wereda, Wereda officials reported that there is one private farm using a diesel pump to irrigate 2-3 ha. Also in Nyangatom, at Kanga ten, the Wereda H.Q., the local authorities operate a pumped irrigation demonstration plot with a variety of mature fruit trees; bananas, mangoes, oranges, lemons and guavas.

Ministry of Agriculture staffs in Kangaten are presently establishing an irrigation trial, training and demonstration area at the new Farmers Training Centre, growing sesame, lentils, cotton, sunflower, sweet potatoes, cowpeas for fodder and vegetables.

In the Kara area of Hamer Wereda, the Ministry of Agriculture operates an irrigation demonstration/training area of 15ha, growing maize, sorghum, beans, tomatoes, cabbage and onions, as well as bananas.

3.3.6 Livestock and grazing resources

3.3.6.1 Livestock Resources

The livestock found within the study area include cattle, sheep, goats, donkeys, camels, poultry and bee colonies. Camels are found in all Weredas, except Salamago, but in limited numbers.

Availability of an accurate estimate of the livestock population is important for assessment of livestock performance and preparation of any livestock development strategy and project.

Similarly, to understand the impact of livestock on individual rangelands, it is necessary to know the number of livestock held by each tribe.

As the pastoralists do not count their animals this information and in general livestock population in the study area is an impediment.

In this study, CSA data is used, where available. In the absence of any reliable information, it was necessary to adopt the recent region (Wereda) livestock number.

Accordingly, the livestock population of the study area is estimated to be cattle 447,882, sheep 256,351, goats 448,955, donkeys 37,613, camel 344, poultry 71,880 and 132,500 bee colonies. This is equivalent to 445,841.6 Tropical Livestock Units (TLU).

Table 3.35: Livestock Population (numbers) in Lower Omo

Wereda	Livestock population						
	Cattle	Sheep	Goats	Donkeys	Camel	Poultry	Bee colonies
Hamer	110,696	84,186	167,670	12,126	24	8,955	90,000
Dasenech	219,380	105,905	206,185	14,144	250	5,231	5,000
Nyangatom	51,806	48,260	55,100	6,343	70	3,694	10,000
Salamago	66,000	18,000	20,000	5,000	-	54,000	27,500
	447,882	256,351	448,955	37,613	344	71,880	132,500

Sources: South Omo Zone and respective Weredas Agricultural and Rural development Offices, 2007

As can be seen in the table, the highest numbers of cattle, sheep, goats, donkeys and camels are found in Dasenech Wereda. The smallest populations of all species are in Nyangatom Wereda.

Table 3.36: Livestock Population (TLU) in Lower Omo

Wereda	Livestock population						
	Cattle	Sheep	Goats	Donkeys	Camel	Poultry	Total
Hamer	86,342.9	8,418.6	16767.0	8,003.2	29.3	89.5	119650.5
Dasenech	171,116.4	10,590.5	20618.5	9,335.0	305.0	52.4	212017.8
Nyangatom	40,408.7	4,826.0	5,510.0	4,186.4	85.4	36.9	55053.4
Salamago	51,480.0	1,800.0	2,000.0	3,300.0	0.0	540.0	59120.0
	349,348.0	25,635.1	44,895.5	24,824.6	419.7	718.8	445,841.7

Note: One Tropical Livestock Unit (TLU) corresponds to livestock weighting 250 kg. Conversion factor adopted for the different species is: Cattle 0.78, Sheep 0.1, Goats 0.1, Equines 0.66, Camels 1.22 and poultry 0.01

The *distribution of livestock* depends on a range of factors including climate, vegetation cover, availability of water, settlement conditions, agro-ecology, farming system, etc.

In most cases cattle are given priority over other livestock species, therefore whenever there is for some reason a decrease in the size of the grazing land cattle will displace sheep. Correspondingly, goats are usually forced to the poorest and most remote ranges.

As can be seen from above tables, cattle are the most important livestock species in relatively higher areas of the study area. In the arid and relatively low-lying Wereda like Dasenech, goats are predominant.

The livestock density of the study area is shown below. The average livestock density for the four Weredas is calculated to be 28.29 TLU/km^2.

Table 3.37: Livestock Density in Lower Omo

Wereda	Area in km^2	Density TLU/km^2
Hamer	7,315.65	16.36
Dasenech	3,283.94	64.56
Nyangatom	1,301.82	42.29
Salamago	3,859.80	15.32
	15,761.21	28.29

The highest livestock density is recorded in Dasenech Wereda (64.56 TLU/km^2) and Nyangatom (42.29 TLU/km^2), while the low density of Salamago (15.32 TLU/km^2) may be attributed to the low human population concentration, and high infestation and incidence of tsetse flies and trypanosomiasis.

Livestock composition in the study area is indicated in the table below. Accordingly, livestock in the aforementioned Weredas is composed of cattle (78.36 %), sheep (5.75 %), goats (10.07 %), donkeys (5.57 %), camels (0.09 %) and poultry (0.16 %).

Cattle accounts for the highest proportion of livestock population followed by goats (10.07%). The large percentage expressed by cattle is substantiated by its versatile contribution to the livelihood of pastoralists.

Table 3.38: Livestock Composition in Lower Omo

Wereda	TLU	Livestock Composition					
		Cattle	Sheep	Goats	Donkeys	Camel	Poultry
Hamer	119650.5	72.16	7.04	14.01	6.69	0.02	0.07
Dasenech	212017.8	80.71	5.00	9.72	4.40	0.14	0.02
Nyangatom	55053.4	73.40	8.77	10.01	7.60	0.16	0.07
Salamago	59120.0	87.08	3.04	3.38	5.58	0.00	0.91
	445841.7	78.36	5.75	10.07	5.57	0.09	0.16

Camel has the least share (0.09%) and is also less importance in the culture of the various tribes, thus the small percentage. Livestock composition on individual Wereda level follows more or less the same ratio.

The number of *livestock owned* is an indicator of the value of resources to the household as well as to the individual within his community. It is a major determinant of the degree of food security.

Whenever opportunities permit every household, especially those belonging to the pastoral community would maximize the number of livestock owned so that a greater sense of security is felt and a reliable hedge against future uncertainty is maintained.

The average livestock holding per person and household in the study area is 2.60 TLU and 13.35 TLU respectively. The highest number per person is recorded in Dasenech Wereda, which has 4.03 TLU/km^2. Similarly, the highest livestock number per household is to be found in Dasenech Wereda (20.09 TLU/km^2).

Table 3.39: Livestock Holding Per Household (HH) and Per Person

Wereda	TLU	Population	HH	Livestock Holding	
				TLU/ person	TLU/ HH
Hamer	119,650.5	61,909	12,381	1.93	9.66
Dasenech	212,017.8	52,665	10,553	4.03	20.09
Nyangatom	55,053.4	23,824	4,967	2.31	11.08
Salamago	59,120.0	32,900	5,495	1.80	10.76
Total/Average	445,841.7	171,298	33,396	2.60	13.35

Livestock breeds in Lower Omo are basically of indigenous type. There are no records of breed identification and characterization as no reliable and comprehensive data have been collected on the existing breeds/types.

The very few animals that are understood to have homogeneous genetic characteristics have been and are being exposed to genetic adulteration also due to the extensive mobility of livestock within and outside respective Weredas.

In this document attempt was made to gather as much information as possible from the informants on the existing livestock breeds in the study area.

Accordingly, the potential livestock breeds or types of importance in the study area are Small Zebu and Borana for cattle, Black Head Ogaden for sheep and Woito for goat.

An important characteristic of these animals is that they are well adapted to the respective local environment, but in retrospect their productivities are low.

The following table shows livestock productivity and performance indicators for the respective Weredas in the study area.

Table 3.40: Livestock Productivity Parameters in Lower Omo

Type of Parameter	Unit	Type of Livestock												
		Cattle		Sheep		Goats		Horses		Donkey		Camel		Poultry
		M	F	M	F	M	F	M	F	M	F	M	F	
Average Age of Sex Maturity	mos	42	42	7	7	8	8	-	-	45	42	72	72	6
Average Interval	mos		18		5		5	-	-		18		24	
Average Productive Life	yrs	5	7	4	3	6	2	-	-	14	12	10	12	1
Twinning Percent	%				18		20	-	-					

Sources: Household Survey and Ethiopian Agricultural Sample Enumeration, 2001/02, Central Agricultural Census Commission, 2003

Generally, livestock are kept for different purposes, which range from their use as food to aesthetic value and culture. The importance of livestock species varies with the farming system, cultural importance of the different species and the livestock type itself.

The general purpose of *keeping cattle* in the study area is for milk, meat, blood, manure, hides, and as a source of cash income, and prestige.

Table 3.41: Reasons for Keeping Cattle in Lower Omo

Wereda	Reasons						
	Draft power	Milk	Meat	Hides	Manure	Cash income	Prestige
Dasenech	-	1	2	3	-	-	3
Hamer	3	1	-	-	-	-	2
Nyangatom	-	1	1	2	-	3	3
Salamago	-	1	-	2	-	1	1

1. most important, 2. less important, 3. marginal

The primary reason for rearing cattle is for milk. Accordingly, the herd composition, management etc. are geared towards milk production.

The other reason for keeping cattle in the pastoral areas is for meat, hides, cash income and prestige. In addition to the output, cattle have an important role and place in the cultural and social functions of the pastoral society.

The role of cattle for traction is of limited importance (only indicated in Hamer Wereda) as there is less cropped land that is cultivated by hand.

Sheep are relatively less common than goats. According to the household survey and focus group discussions, sheep are reared mainly for own use and as a source of cash income. Small ruminants are sold in exchange for cash in order to purchase their subsistence material needs.

Male are sold at young age and as a result, and the flock composition is more biased toward female. Sheep are also reared for hides, prestige and milk and used by Hamer as marriage gift.

Table 3.42: Reasons for Keeping Sheep in Lower Omo

Wereda	Reasons					
	Milk	Meat	Hides	Manure	Cash Income	Prestige
Dasenech	3	1	2	-	-	3
Hamer	3	3	-	-	1	2
Nyangatom	-	1	1	-	-	3
Salamago	-	1	-	-	1	-

1. most important, 2. less important, 3. marginal

Fast growth, production rates and high recovery rates especially after drought, together with their ability to survive on varied vegetation have given significant role to *goats* among the pastoralists, which are reared as a source of cash income to cover household needs and meat as well as for milk, hides and as a sign of prestige.

Table 3.43: Reasons for Keeping Goats in Lower Omo

Wereda	Reasons					
	Milk	Meat	Hides	Manure	Cash income	Prestige
Dasenech	2	1	3	-	-	3
Hamer	2	3	-	-	1	3
Nyangatom	1	1	2	-	-	3
Salamago	2	1	1	-	1	-

1. most important, 2. less important, 3. marginal

Goat milk is one of the food items in the Lower Omo pastoral society. It is consumed by the whole household both as it is and in the form of butter and sour milk. It is regarded as having important medicinal properties and often commands substantial price premiums over cow milk. Children use it as whole milk while adults usually drink it with tea. Among the small ruminants, goats are most preferred as marriage gifts.

As horses and mules could not stand the harsh environmental condition of the lowlands, these are almost unknown there. *Donkeys* are the only equines that survive in the pastoral area of lower Omo. According to the household survey, the reason for keeping donkeys is for being used for traction power in Dasenech, Nyangatom and Salamago Weredas. They are rarely utilised to transport goods and services.

Table 3.44: Reasons for Keeping Equines in Lower Omo

Wereda	Reasons						
	Draft power	Milk	Meat	Hides	Manure	Cash income	Prestige
Dasenech	1	-	3	-	-	2	3
Hamer	-	-	-	-	-	-	-
Nyangatom	1	-	-	-	-	-	3
Salamago	1	-	-	-	-	-	3

1. most important, 2. less important, 3. marginal

Donkeys are not kept in large numbers and the few existing are designated to carry lame people.

Camels are very few in number. In Hamer Wereda, they were introduced by an NGO only very recently. The importance of those that exist in the study area is for their milk and meat. Sometimes, they are sold as source of cash income. In very rare cases, a few pastoralists cultivate agricultural plots with camels.

Due the mobile nature and culture of the various tribes, *poultry* is very rare in the study area.

As indicated in the following table, the main reason for raising poultry is as a source of cash income. This is through the sales of live birds and eggs. Cash from poultry sales is generally used to purchase grains and other essentials to supplement their energy-deficient diet of milk and milk products.

Table 3.45: Reasons for Keeping Poultry in Lower Omo

Wereda	Reasons				
	Meat	Hides	Manure	Cash income	Prestige
Dasenech	1	-	-	2	3
Hamer	-	-	-	1	-
Nyangatom	3	-	-	1	-
Salamago	-	-	-	1	-

1. most important, 2. less important, 3. marginal

For what concerns *livestock management practices* in the study area, though the pastoralists give importance to livestock, the management system followed is traditional. This is due to lack of awareness, poor extension services and remoteness or the areas.

Nevertheless, in their own way, pastoralists do not keep more animals then they need for survival and do not own enough livestock to subsist from livestock products alone. In fact, the groups in the lower Omo nowadays own far less livestock than they used to. This is due to incidence of diseases, population pressure, inter-ethnic conflicts and land shortage.

While discussing livestock management system, the main topics taken into consideration include: herding, breeding, feeding and housing.

Herding: livestock stay most of the time in the rangelands. In the settlement areas, they leave the homestead early in the morning and come back late in the afternoon spending all the time grazing with break for water in the middle of the day. If they have to stay in a particular area for many days, then it may be necessary to construct temporary fences. Otherwise, they are out in the open. They normally stay in a certain area as long as there is water and forage. In the permanent settlement areas, young boys and girls take care of livestock while in the course of migration to some other place, grown up male handles livestock.

Breeding: natural mating is the common system of livestock breeding. No bull selection is practiced. All livestock of both sexes graze together, where there is the chance for any bull to mate with any cow or heifer. As a result calving takes place any time of the year. Sometimes, the pastoralists try to synchronize mating so that calving happens at the time that pastures are more abundant.

Feeding: Natural pastures are the main source of feed for livestock in South Omo Lowlands. In areas where recession agriculture is practices, animals are supplemented with crop residues.

Housing: No shelters are constructed for livestock. The only construction made is perimeter fencing for the night with locally available materials (branches of trees, bushes, thorns, etc.). Even this is done in situations where there is threat of predators or livestock raiding.

*Others***:** In the drier parts of the lower Omo livestock watering points attract high livestock concentrations in the course of the dry season, thus causing overgrazing of such areas, whereas localities far from water sources tend to be under-grazed. Nomadic pastoralism in the drier lowlands is characterized by seasonal migratory movements of livestock in search of feed and water within specific ethnic territories.

Livestock Migratory Patterns are a rational and efficient response of the pastoralist to the exploitation of the arid environment. The agro-pastoralist groups of the lower Omo move seasonally to make the best use of available resources in an environment when rainfall is uncertain. Patterns of movement are influenced by:

- Availability of vegetation for grazing and browsing, season by season;
- Availability and access to water;
- Relationships with other tribal groups (long-term inter-tribal agreement and state of current relationships);
- Incidence of livestock diseases (trypanosomiasis, internal parasite infestations);
- Dietary need of people (milk and to a lesser extent meat);
- Need to provide rainfed and flood recession staple crops;
- Access to schools in some cases.

The extent of migration is determined not only by seasonal patterns of rainfall, but also by variation from year to year and from place to place.

Customary grazing practices are, therefore, flexible, so that a group that is short of grazing can utilize at least part of the neighbouring tribe’s range. There are often buffer areas available to adjacent groups according to need. Such an arrangement is often disrupted during times of tension between tribes.

Consequently, these buffer rangelands are under-used at such times.

There are three basic forms of transhumance in the lower Omo.

Firstly, during the dry season when grazing is scarce, several groups (Mursi, Bodi and Nyangatom move their livestock towards the Omo to water their livestock. During the wet season, they move their livestock away from the river. This is due to the fact that it is impossible to keep livestock there because of the tsetse challenges.

Secondly, movement with the livestock occurs from higher altitudes to lowlands in the course of the dry season and vice versa during the wet season, when sufficient pasture becomes available in the mountains and water returns in the dry riverbeds. This is commonly practiced by the Hamer, Tamaqua and Banana tribes.

Thirdly, along the Omo River, when the floods are greater in one part of the river, there can be migrations by groups living in other parts (eg. the Karo may move to the Dasenech).

Further, highland herds usually contract during the wet season and disperse in the dry season, while lowland herds disperse during the wet season and contract in the dry season.

3.3.6.2 Feed resources

The major sources of feed for livestock in the study area are represented by natural pastures, aftermath grazing and crop residues. There are also other sources to be found in smaller amounts, including industrial by-products, improved forage and thinning/weeds. The following table shows sources and contribution of the feed in the different Weredas of the study area.

Table 3.46: Livestock Feed Type and Contribution in Percentage for Lower Omo

Wereda	Feed type and contribution in %				Total %
	Natural pastures	Flood recession	Crop residues	Improved forage	
Dasenech	25	60	10	5	100
Hamer	94	6	-	-	100
Nyangatom	89	10	-	1	100
Salamago	82	6	8	4	100

Source: Dasenech, Hamer, Nyangatom and Selamago Agricultural and Rural Development Offices, 2007

As can be seen in the table, natural pastures contributed the greatest followed by crop residues that are usually a result of the recession agriculture. In fact, an important feature in all the four Weredas is that feed is also obtained because of the recession of the flood from the Omo River.

The importance increases as one move downstream. The least (6% each) is in Salamago and Hamer Weredas (upstream) and increases reaching the top (60%) in Dasenech Wereda (lower stream). This feed source will not be available for some part of the year as the land would be submerged.

As the water recedes, pastoralists follow the dry inundated pasturelands as soon as the water level decreases and grasses start to grow. Livestock are grazed on this resource for part of the year or for the remaining season until the next flooding.

Assuming that the area in the Omo River Delta pertaining to Dasenech Wereda covers 189.8 km^2 or 18,982.4 ha, this represents about 15% of the entire Wereda.

The vegetation cover in the delta mainly consists of elephant grass (Napier grass). With an average annual production of 25 ton of dry matter per ha, the total potential dry matter production can be calculated in the range of 474,560.75 ton.

At the rate of 2.28 ton per TLU per annum, this biomass if properly managed and utilized could sustain 208,140.7 TLUs. Though it was not possible to get the exact number of livestock grazing on it, according to Wereda Officials, almost all of the Wereda livestock as well as other cattle from adjacent areas depend on it for the whole year, with the only exception being represented by the flooding period.

Commonly most of the forage is lost through trampling as livestock remains permanently on site without any rotation or other improved management system. The above show how important is the Omo River delta for survival of livestock.

Crop residues represent the second most important source of livestock feed. Their contribution is in Dasenech (10 %) and Salamago (8 %). These are available only part of the year after crops are harvested.

Such feed is mostly used by pastoralist more or less settled along the Omo River. It lasts for only short period of the year, as there are no proper conservation and management systems followed.

Feed in the form of dry matter are obtained mainly from natural sources table and crop land. From the former source, the highest contributor is Grassland, which accounts for 44.9 % of the total dry matter production.

This is followed by Bushland, Shrubland and Riverine Forest producing 340,560.9 ton (33.2 %), 90,422.2 ton (8.8 %) and 34,022.0 (3.3 %). These sums up to a total annual dry matter production (from natural sources) of 1.028 million ton.

Table 3.47: Biomass Yield in Lower Omo

Land cover	Area (ha)	Herbage Yield Dry Matter (ton/ha)	Total Production (ton)	% of Production
Bushland	162,560.6	1.8	292,609.1	28.5
Bushland thicket	95,903.6	0.5	47,951.8	4.7
Bare soil	63,879.9	0.5	31,940.0	3.1
Cultivated	5,354.9	1.8	96,38.8	0.9
Grassland	102,617.5	4.5	461,778.8	44.9
Marshland	6,186.1	4.5	27,837.5	2.7
Plantation	2,557.2	1.0	25,57.2	0.2
Riverine Forest	37,802.2	0.9	34,022.0	3.3
Shrubland	56513.9	1.6	90,422.2	8.8
Residual Water	165.9	1.4	232.3	0.0
Woodland	15,309.5	1.9	29,088.1	2.8
Total	548,851.2		1,028,077.6	100.0

Source: Calculated from Agriconsulting / MDI Land Cover data, 2007

For what concerns crop land, sources of feed are in the form of crop residues and aftermath grazing. This is obtained from maize and sorghum crops. The total amount of dry matter expected from crop lands is 53,284 ton per annum.

Table 3.48: Crop Land in Lower Omo

Wereda	Area Covered with Crop (ha)	DM Yield (ton/ha)		Total DM Production (ton)
		Crop Residues (1.4 ton /ha)	Aftermath Grazing (0.4 ton /ha)	
Dasenech	7,650	10,710.0	3,060.0	13,770.0
Hamer	10,139	14,194.6	4,055.6	18,250.2
Nyangatom	2,703	3,784.2	1,081.2	4,865.4
Salamago	9,110	12,754.0	3,644.0	16,398.0
Total	29,602	41,442.8	11,840.8	53,283.6

Source: Agricultural Sector Report, 2008

Overall dry matter expected from the different sources (natural pastures and crop residues) is of 1,081,361.2 ton.

Natural feed sources in the study area are represented by grasses, legumes, bush/shrubs and trees. Summary of the herbage compositions is indicated in the following table.

Table 3.49: Major Natural Pasture Composition in Lower Omo

	Natural pasture type			
	Grass	Legume	Bush/shrub	Tree
Grassland	Echinichloa colona	Trifolium sp.	Balanites aegyptiaca	
	Eragrostis sp.		Salvadora sp.	
	Cendhurus sp.		Ziziphus	
	Digitaria sp.		Acacia sp.	
	Pennisetum sp.			
	Chrysopogon ancheri			
	Leptothruium sp.			
	Dactyloctenium sp.			
	Enneapogon sp.			
	Paspalidium sp.			
	Eriochloa sp.			
	Sporobolus spicatus			
	Cynodon dactylon			
	Leptochloa rupenstis			
	Paspalum sp.			
Bush grassland	Hackelechloa sp.	Tephrosia sp.	Maytenus sp.	Boscia sp.
	Heteropogon contotus	Rhynocosia sp.	Sesbania sesban	Combretum green wayi
	Eulalia sp.	Glycine wightii	Acacia sp.	Grewia sp.
	Setaria sp.	Indigofera sp.	Aeschynomene sp.	Acacia sp.
	Brachiaria sp.	Vigna sp.	Terminalia sp.	Harrisonia
	Sorghum sp.	Aeschynmene sp.	Rhus sp.	
	Chloris sp.	Indigofera		
	Panicum sp.	Crotarlaria		
	Hyparrhenia sp.			
	Themeda triandra			
	Panicum sp.			
	Hypertilia sp.			
	Chrysopogon plumulosus			
	Sporobolus fimbriatus			
	Bothriochloa sp.			
	Halopyron mucronatum			
Bushlands	Heteropogon contortus	Desmodium sp.	Acacia sp.	
	Eragrostis superba		Harrisonia abyssinica	
			Terminalia browni	
Woodlands	Panicum maximum			Comretum molie
				Terminalia sp.
				Pilostigma thornningii
				Acacia sp.
				Harrisonia abyssinica
				Dicrhrostachys cinerea
				Grewia sp.
				Protea sp.

Source: Omo-Gibe River Basin Integrated Development Master Plan Study Final Report, 1996

Generally, in Ethiopia all land belongs to the Government, though using rights of grasslands may be either under government, communal or private responsibility. In the case of the lower Omo, land in all the four Weredas is communally owned. In general terms such rangelands are not in good conditions as each pastoralist tries to maximize their use by maintaining as much livestock as possible.

There is wide variation in the availability of different feed types in the basin. Natural pastures are available for livestock throughout the year. The biomass is abundant during the wet season and a few months thereafter. It, however, dwindles as the dry season progresses and not much is expected just before the beginning of the rainy season.

Generally, rangelands in the study area are getting smaller as land is used for some other purposes. These include:

Reservation of land for National Park and controlled areas: the exclusion of some pastoralist groups from their traditional dry season grazing areas has had a severe effect on their subsistence.

Expropriation of land for Government projects (eg. the Ethio-Korean irrigation project).

Cultivation, as land that is being cultivated is unavailable for grazing, during the growing season.

Bush encroachment

Daily, livestock require maintenance feed equivalent to 2.5% of its body weight. This corresponds to 2.28 ton dry matter per annum per TLU. At this rate, the total amount of feed annually needed to satisfy the livestock population of the study area is estimated to be 1.01 million ton.

Table 3.50: DM Required for Livestock in Lower Omo (Ton)

Livestock Type	TLU	DM ('000 ton) (a)
Cattle	349,348	796.51
Sheep	25,635	54.45
Goats	44,896	102.36
Equine	24,825	55.86
Camel	420	0.96
Total	445,124	1,010.14

Note: *Annual Dry Matter requirement to adequately maintain on TLU was calculated on the basis of 2.5% of lives weight per day. This is equivalent to 2.28 ton/annum/TLU. Adopted from Janke, E.H. (1993), EHRS.*

Though intensity may vary, feed shortage is a common phenomenon in the study area. The following table shows result of household survey conducted by the Omo-Gibe Master Plan study (1996) on the experience of feed shortage and when it occurs. All Weredas in south Omo come across feed shortage.

Table 3.51: Seasons of Feed Shortage

Wereda	Occurrence (%) Season of the year				Pastoralists experiencing shortage (%)
	Winter Dec, Jan, Feb	Summer Jun, Jul, Aug	Autumn Mar, Apr, May	Spring Sep, Oct, Nov	
Mursi and Bodi	96.7		3.3	-	72.1
Kuraz	13.9		5.6	80.6	88.9
Bena Kule	100		-	-	95.5
Bako Gazer	92.0		8.0	-	48.6
Hamer	96.7		3.3	-	97.7
	75.7	00	4.2	20.1	76.7

Source: Omo-Gibe River Basin Integrated Development Master Plan Study Final Report, 1996

There is no feed shortage in the rainy season. The feed shortage periods are seasonal and are generally manifested sometimes after the end of the rainy seasons.

As can be seen in the table, feed shortage occurs in the dry season in all Weredas and in very same extent again in all Weredas, except in Bena Kule Weredas in the small rainy season. Only in Kuraz Wereda does feed shortage happen in Tsedey.

Generally, feed shortages are manifested a few months before the beginning and end of the rainy season. At the beginning, fodder at had will be depleted and at the end it will not be ready.

3.3.6.3 Livestock water needs

Water for livestock is needed for maintenance and production. Generally, about 85 % is used for maintenance and the rest (15 %) for production. The products could be one or a combination of milk, meat, hair, wool, eggs, etc.

The sources of water for livestock in the study area are rivers, springs, lakes, pond, wells and swamps. The distribution and when the different sources are used are shown in the following table.

Table 3.52: Source of Water for Livestock in lower Omo

Wereda	Sources of water and time of use						Distance km
	River	Spring	Lake	Pond	Well	Swamp	
Dasenech	WD	-	WD	W	-	W	10-50
Hamer	WD	W	-	W	WD	-	5-15
Nyangatom	WD	-	-	W	-	WD	2-10
Salamago	WD	-	-	W	-	-	15
D: Dry season W: Wet season							

Source: Field survey made by MDI Engineering and Agriconsulting Spa., 2007

Major rivers of the area and some of their main tributaries in the respective Weredas of the study area are permanent and dependable sources of water. There are also other intermittent rivers and streams that are accessible only part of the year.

According to the Wereda survey, springs are to be found mainly in Hamer Wereda. On the other hand, Lake Turkana supplies water to livestock in Dasenech Wereda.

Ponds can be either man-made or natural depressions. These are found in the four Weredas of the study area. As in most cases, ponds are not enclosed and are therefore usually contaminated with urine faeces, etc making the water quality very poor.

Swamps are both permanent / seasonal sources of water and often also in many cases of fodder. This type of water sources exists in Dasenech and Nyangatom Weredas.

Other sources of water for livestock are represented by shallow and deep wells. This has been reported in Hamer Wereda only.

During the dry season, most of rivers and springs dry-up or see their water storage greatly diminishing. Ponds as well may last 2-3 months and dry-up. At this time pastoralist take their livestock to water sources further away from the farmstead or endeavour to provide water.

In dry periods Livestock are also watered every other day or more, while most pastoralists take their cattle to remaining watering points further away from the farmstead.

Table 3.53: Estimated Daily Drinking Water requirement on Non-Lactating Livestock under African Condition (litres)

Livestock Type	Weight (kg)	Mean	Maximum	For Planning Purpose
Cattle	350	16.4	56.1	25.0
Sheep	35	1.9	5.2	5.0
Goats	30	2.0	5.4	5.0
Equine				12.0
Camel	500	18.4	34.0	30.0

Source: Richard M. Holt and Bashir B. Buh (1995) from Herlocker

Accordingly, the water demand for livestock in the respective Weredas is calculated on the basis of the above table and amounts to 5.54 million m^3.

Table 3.54: Water Requirement for Livestock in Lower Omo

Livestock Type	Livestock number	Avg. Annual Water Requirement (cum)	Water demand '000 m^3	Percent Share
Cattle	447,882	9.13	4,086.92	73.74
Sheep	256,351	1.83	467.84	8.44
Goats	448,955	1.83	819.34	14.78
Donkeys	37,613	4.38	164.74	2.97
Camels	344	10.95	3.77	0.07
Total			5,542.62	100.00

3.3.6.4 Animals Health

A wide range of livestock diseases affect animals in the study area. These are Bacterial, Viral, Protozoa diseases, Internal and External Parasites. The ones that are more common include:

Cattle: TBD, Contagious Bovine Pleuro-pneumonia (CBPP), Anthrax, Foot and Mouth Disease (FMD), Trypanosomiasis, Lumpy Skin Disease (LSD), Gastro Parasitic Enteritis (GPE), pasteurellosis, Blackleg;

Sheep: Pneumonia, External Parasites, Internal Parasites, foot rot, Gastro Parasitic Enteritis (GPE);

Goats: Contagious Caprine Pleuro-pneumonia (CCPP), External Parasites, Internal Parasites,

Camel: Trypanosomiasis, external parasites, Pneumonia;

Poultry: New Castle Disease (NCD), salmonellosis, coccidiosis, fowl tick;

Due to unlimited and uncontrolled movements of livestock, chances increase enormously for the spreading of diseases. This however may have little and or no effect on the local market, as it is quite a common occurrence throughout the area, though it is most felt for what concerns the export market.

Potential importing countries, in fact, often do not allow live animals into their territories for fear of transmission.

Diseases also damage the quality of hides and skins, which are the second foreign exchange earning product. Animal health infrastructures that serve the Weredas in the study area are limited and severely handicapped by lack of resources.

Table 3.55: Veterinary Infrastructure in Lower Omo

Wereda	Types of Facilities		
	Clinic	Animal Health Post	Private Drug Shop
Dasenech	1	6	1
Hamer	1	8	4
Nyangatom	1	5	1
Salamago	1	4	-
Total	4	23	6

These services, if coupled with the general lack of all weather access to most areas, are wholly inadequate to deal with the problems of the livestock sector and will have to be substantially strengthened and upgraded if livestock productivity is to be improved.

Generally, responsibility for delivery of veterinary services lies mainly with the respective Regional States. The veterinarians, Animal Health Assistants, Animal Health Technicians and some case Community Based Animal Health Workers undertake the duties.

The participation and services of the private veterinary sector is limited and concentrated in major Wereda centres. Most of the activities involve sales of drug.

3.3.6.5 Livestock Marketing and Economics

The Lower Omo River Basin is under-developed and remote. Access and other infrastructure, road, market, etc are very poor. Existing livestock markets in the area are mainly bush markets. In some Weredas primary type of markets exist. The following table shows the livestock markets in the study area (No markets are present in Nyangatom).

Table 3.56: Livestock Markets in Lower Omo Valley

Wereda	Market name	Type of market	Days held	Markets outside the respective Weredas
Dasenech	Omorate	Primary	Tuesday and Saturday	
Hamer	Dimeka	Primary	Saturday	Mojo
	Turmi	Primary	Monday	Debre Zeit
	Erbore	Primary	Monday	Bena Tsemay
Salamago	Hanna	Primary		Jinka
	Giyo	Bush market		Mesketo

The livestock owners exchange animals among themselves. Occasionally, traders come and buy livestock.

The only organized livestock market in Dasenech is found in Omorate town, established with the support of an NGO to provide services to livestock owners and traders. There are about 28 traders that export livestock, mainly cattle direct from Omorate to the central markets. They use small trucks (Isuzu) for transportation.

The cattle sent in this manner to the central market were about two thousands per year for the last three years. Last year 1,600 sheep and goats were also sold. On the other hand, most livestock is traded illegal across the border to Kenya by Somali traders.

Pastoralists and agro-pastoralists in Hamer Wereda get market services mainly in Dimeka town. Other further away markets include Key Afer and Turmi. Since markets are very rare, the majority of the community do not have outlet for their livestock.

The rest of trading is between pastoralist and sometimes traders come along and buy livestock. Pastoralists in Karo have indicated that they travel three days to reach Turmi market.

The only livestock market for Salamago is Hanna. With minor ones being Mesketo Special Wereda (two days travel from Hanna) and Jinka.

Table 3.57: Livestock Market Prices

Type	Dasenech		Hamer		Nyangatom	
	Price (Birr)		Price (Birr)		Price (Birr)	
	High	Low	High	Low	High	Low
Cattle						
Steer			1,800	1,200	1,200	1,000
Oxen	1,600	1,000	1,300	860		
Bulls			1,090	870		
Cows	1,200	600	550	350		
Heifers						
Calves (m)			580	420		
Calves (f)			780	750		
Sheep						
Castrated (fattened)			250	140		
Male (rum)	230	140	180	146	70	60
Ewe (barren)			140	125		
Ewe			55	40		
Lamb (M)			100	40		
Lamb (F)			115	60		
Goats						
Castrated (fattened)			380	270		
Male (buck)	270	160	220	180	120	80
Doe (barren)			160	150		
Doe			180	175		
Kid (M)			100	80		
Kid (F)			110	90		
Poultry						
Cock			20	8	8	5
Hen			10	6		

Table 3.58: Livestock Products Prices

Types of Livestock products	Hamer	
	2006 Price (Birr)	
	H	L
Milk (cow)	2/lt.	1.5/lt
Butter/ghee	18/kg	12/kg
Eggs	3 eggs/2	3 eggs/1.5
Skins (sheep)	2/pc	1.5/pc
Skin (goat)	6/pc	4/pc
Honey	15/kg	10.5/kg

As can be seen in above table's prices for livestock and livestock products are low. This is due to absence of market and cultural restrictions to sell livestock products.

3.3.7 Public Health

The health status of the community is poor especially among children below five years and pregnant women. Communicable diseases are particularly felt and may be mainly attributed to the poor state of living of the community, living in congested dwelling area coupled by lack of adequate and safe drinking water and sanitation and poor nutrition.

The ten top diseases as reported by the health institutions in the four Weredas are presented in the table below.

Table 3.59: Ten Top Diseases (cases) Diagnosed by Wereda (G.C. 2007)

Sr.No	Diseases	Hamer	Salamago	Nyangatom	Dasenech
1	Malnutrition	158	428	45	-
2	Eye diseases	94	22	908	56
3	Upper respiratory infection	204	29	1385	1762
4	Malaria	4018	4860	1464	2917
5	TB	47	8	40	63
6	Intestinal parasites	480	980	1362	625
7	Gastritis	305	380	200	255
8	Pneumonia	600	630	-	291
9	Urinary tract infection	-	26	1341	215
10	Skin diseases	-	240	202	538
11	Diarrhoea	377	302	185	638
12	Helminthiasis	-	310	-	152
13	AIDS	680		7	37
14	Birth Related Complications	19	6	12	2
15	STDs and Other Diseases	31	210	-	443

Source: Wereda Health Office of each Wereda

Health status of the community is made worse by a number of harmful practices mainly attributed to lack of awareness and traditional belief of the people. These include pre-marital and extra-marital sexual practices, early marriage and abduction, massage of pregnant women, using local medicine and Tattooing, unsafe sexual intercourse, female circumcision.

The Health Bureau is responsible to provide health care in the Region through the operation of a comprehensive health care network within the limits of the available resources. In addition to the Health Bureau, Non-Governmental Organisations (NGOs) and Other Governmental Agencies (OGAs) are involved in the Region.

Currently available health facilities in the project areas are depicted in the Table below: noteworthy the absence of a hospital in all of the four surveyed Weredas. The result of the surveyed indicates that there are limited health facilities at various levels in the study area.

Table 3.60: Available Health Facilities by Wereda (2007)

Health Facilities	Number of Facilities			
	Nyangatom	Salamago	Dasenech	Hamer
Hospital				
Health Clinics		1		
Health Centres	1	1	1	3
Health Posts	5	10	8	12
Pharmacies	1	1		1
Total	7	13	9	16
Population to Health Facility Ratio	3403	2741	5851	3869
Population to Health Centre Ratio (Target: 1 health centre to 25,000)	23824	32900	52665	20636
Population to Health Post Ratio (target: 1 health post to 5,000)	4764	3290	6583	5159

Source: Wereda Health Office and direct observations

According to information obtained from Wereda offices, the total population that is served by the existing health facilities and drug-outlets in the four Weredas is estimated to be less than 175,000. The result of the ratios of population to health centre and post health is far below the standards stipulated by the Ministry of health (MOH).

3.3.8 Education

Realizing the positive role that education plays in the development of a society and reducing poverty, the Ethiopian government has adopted a new *Education and Training Policy (ETP)* in 1994.

The document outlined the mission and goals of the new education system for Ethiopia to achieve the present and future National economic and social development goals. The policy focuses on increasing access to educational opportunities with enhanced equity, quality and relevance.

This was the basis for a multi-year Educational Sector Development Program (ESDP) that started in 1997/98 with the long-term goal of achieving universal primary education by the year 2015.

In the South Omo Zone, there are 113 schools of which 40% are concentrated in the Bako Gazer Wereda. It is important to mention that no clear data regarding school enrolment, classes etc. are available for some less easily-accessed Wereda.

The following table clearly demonstrates the total number of the students is medium-low in respect to the potential total population in the different Weredas.

Table 3.61: Distribution of schools by grade level

Zone/Wereda	Grade															Total
	1-1	1-2	1-3	1-4	1-5	1-6	1-7	1_8	5_8	7_8	9-9	9_10	9-11	9-12	10-12	11_12	
Region	254	288	163	1339	69	93	127	1024	36	5	15	74	6	31			3524
South Omo	6	9	4	65	1	1		21	4			1		1			113
Bako Gazer	2	5	1	31				7	2			1					49
Bena Tsemay	2	2		7		1		1									13
Gelila	2			13	1			5	1								22
Hamer			1	4				2									7
Dasenech				6					1								7
Salamago		2	2	4				1									9
Jinka Town Ad.								5						1			6

Source: Field survey made by MDI Engineering and Agriconsulting Spa.

Table 3.62: School Age Population by Cycle

Zone/ Wereda	For Primary School First Cycle (7-10 Age)			For Primary School Second Cycle (11-14 Age)			For Secondary School First Cycle (15-16 Age)			For Secondary School Second Cycle (17-18 Age)		
	M	F	T	M	F	T	M	F	T	M	F	T
Region	922.331	922.404	1.844.735	664.669	641.596	1.306.265	362.562	337.079	699.640	278.438	292.921	571.360
South Omo	29.995	28.692	58.687	20.781	18.549	39.329	10.936	9.214	20.151	9.010	8.823	17.833
Bako Gazer	15.102	14.695	29.797	9.899	9.004	18.903	5.073	4.590	9.663	4.209	4.421	8.630
Bena Tsemay	2.581	2.368	4.949	1.965	1.699	3.664	1.128	886	2.014	923	843	1.766
Gelila	3.513	3.346	6.859	2.212	1.968	4.180	1.118	997	2.115	913	947	1.859
Hamer	2.669	2.517	5.186	2.050	1.807	3.858	1.174	947	2.121	963	903	1.866
Dasenech	4.928	4.601	9.529	3.747	3.284	7.030	1.978	1.372	3.349	1.620	1.307	2.927
Salamago	1.201	1.165	2.367	907	787	1.695	466	422	889	382	402	785
Jinka Town Ad.												

Source: Field survey made by MDI Engineering and Agriconsulting Spa

The above table shows how the gender gap for the cycles progressively increases as age increases (in some cases home-school is an alternative to formal education). This trend is likely to remain constant without public intervention.

3.3.9 Trade

One of the consequences of the trade weaknesses is the limited money circulation also due to the inadequacy of the banking and credit system, and of the communication infrastructures. Roads and other facilities have not been constructed to support the development process in the South Omo Zone. It is estimated more than 50% of the rural population reside more than 25 km away from an all weather road.

Agricultural development is affected by market outlets that are underdeveloped and low potential demand in many areas of the basin. Market accessibility is influenced by problems of transportation and logistics as well as low demand for particular products, with most of these factors being interrelated. Potential demand for agricultural products is constrained by:

Erratic and insufficient supplies of agricultural commodities

Poor state of market infrastructure

Sparse population of Salamago, Dasenech, Nyangatom, Maji and Hamer Wereda

Low levels of disposable income of South Omo Zone inhabitants

Poor network of all weather roads and the reality that a large proportion of the rural population live at a considerable distance from them

Table 3.63: Private investment and job opportunity by sector

Zone/Wereda	Sector	Status	No of projects	Capital	Permanent employment	Temporary employment	Total employment
Bako Gazer (Where Jinka capital)	Agriculture	Pre-implementation	1	4.100.000	28	250	278
Bako Gazer	Hotel and Tourism	Pre-implementation	1	900.000	12	38	50
Bako Gazer	Industry	Pre-implementation	2	2.760.680	17	312	329
Jinka town	Social Service	Pre-implementation	1	300.000	18	4	22
Turmi	Hotel and Tourism	Operational	1	500.000	15	5	20
Omorate	Bio-Diesel Industry	Operational	1	-	-	-	-
Benna Tsamay	Cotton Industry	Operational	1	30.000.000	200	1600	1800

Source: Field survey made by MDI Engineering and Agriconsulting Spa.

Each Wereda has active weekly markets. Livestock markets usually operate on one trading day per week. Main markets can be held on one, two or three days per week. Secondary markets normally have only one trading day each week.

Picture 15: Hamer Dimeka market

Organised market facilities are entirely absent, and trading is conducted without any protection from the elements. Even local handmade trader's stalls, providing rudimentary trading counters are unknown.

If trading fees were collected from the market traders by the Wereda administration, they could be used to provide basic market facilities and would allow the traders to press for market improvements; currently this does not occur.

Market hygiene is particularly adverse on all the trading sites. Public health risks are significant.

Many rural markets lack a market site in addition to the absence of market facilities. In rural locations markets are often conducted on and across the main road leading through the centre of the village or town.

The following table shows that even though the rural status of the concerned Wereda has a low money flow, the Wereda revenues still seem to be achieved as expected.

Table 3.64: Revenue planned vs. collected (2005)

Wereda	Planned revenue	Revenue collected in 2005	% Achieved
Salamago	272.432	418.987	153,8%
Dasenech	553.290	389.673	70.4%
Nyangatom	293.500	187.971	110%
Hamer	360.102	729.137	202,5%

Source: Regional Revenue Authority

3.3.10 Tourism

As tourism data are limited, information was obtained mainly from interviews and questionnaires in Hamer, Nyangatom, Salamago and Dasenech Weredas. Tourism in the South Omo Zone is still limited and based on small groups interested essentially in natural resources (Parks, natural reserves, animals, the Omo River) and ethnic attractions.

In particular Mago National Park is the main tourist destinations.

For this reason the Ministry of Natural Resources Development and Environmental Protection (MNRDEP) and the Ethiopian Wildlife Conservation Organization (EWCO) have identified a National Conservation Strategy to protect natural resources and the National Tourism Development Plan in order to promote tourism in the area.

The Plan proposed that marketing and development be concentrated in the south with nature-specialization for small groups. These would consist of 13-21 day safaris through southern Ethiopia with accommodation in tents or “ecological accommodation” located in or close to the National Parks.

The weakness of the infrastructure represents constraints on tourism development. The lack of all-weather roads and airstrips increases the difficulties for private tour operator organizations. The National Tourism Development Plan’s strategy consists of:

- Upgrading roads from: Sodo to Jinka; Arba Minch to Jinka, Key Afer to Turmi,
- Upgrading airstrips in Jinka, Arba Minch and Maji,
- Upgrading airstrips in Mago and Omo National Parks,
- Construction of circulars roads in Mago (150 km) and Omo (250 km),
- Rehabilitation of existing buildings, and
- Construction of houses, schools, hostels and dispensary in Omo and Mago National Parks.

Table 3.65: Tourism analysis data

		Wereda			
		Salamago	**Dasenech**	**Nyangatom**	**Hamer**
Tourism infrastructure					
	N° of Hotels				3
	N° of local tourist guide	2			10
Things to see					
	Hot springs	2		2	
	Unique vegetation	2			
	Wildlife	3		2	3
	Birds	2		2	3
	High mountains	2			
	Archaeological site	2		2	2
	Historical places				2
	Unique ethnic tradition	3	4	3	4
	Religious sites	1			
Things to do					
	Trekking	1		1	
	Horseback or Camel riding	1		1	
	River rafting	1	3	1	
	Sport fishing	1		1	4
	Mountain climbing	2		1	
	Rock climbing			1	
	Cultural festivities	3	3	2	3
	Hunting				3
Tourist attendance					
	Average number of attendant per month		100	30	150/200
	Total number of attendant				
	Pick tourist attendant month	August-September	October	November January	June, January
Score:					
1=no major attraction, 2=visit only when close by					
3=major attraction, 4=potentially attractive, needs development					

Source: Field survey made by MDI Engineering and Agriconsulting Spa.

The most important tourist activity is wildlife viewing and hunting safaris. The rivers, especially the Omo, have large and varied stocks of fish, which might attract anglers. The Parks and CHA's continue to be the final stage of rafting expeditions.

The scenic quality of the whole Basin is generally very high. With its numerous mountain ranges, deep valleys, savannah, forest and woodlands it presents a continuously changing topographical picture.

The valleys of the Gibe and Omo Rivers and their tributaries vary from narrow gorges hemmed in by bare rock-faced precipices to wider valleys of steep or gentle sloped forests at lower levels.

The following table represents an estimate of holiday tourists in the Region and in the Omo Basin based on the analysis of the data provided by the Regional Tourism, Parks and Hotels Commission.

Table 3.66: Annual Tourist Arrivals in the SNNPRS Region

Year	Ethiopians	Foreigners	Total	Total income in Birr	Percent increase
1997	59.154	9.270	6.842	1.424.965	13,0
1998	61.224	12.973	74.197	2.140.731	50,2
1999	48.740	12.634	61.374	5.122.769	139,3
2000	77.836	10.126	87.962	4.007.447	-21,8
2001	129.362	14.876	144.238	7.571.518	88,9
2002	102.270	20.000	122.270	7.002.006	-7,5
2003	101.000	22.000	123.000	7.007.116	0,1
2004	41.871	102.135	144.206	6.424.337	-8,3
2005	157.187	31.225	188.416	8.663.100	34,8
2006	200.000	38.814	238.814	12.260.000	41,5
Total	1.027.974	284.933	1.251.529	62.885.449	

Source: Regional Tourism, Parks and Hotels Commission

Many foreign tourists visit SNNPRS in order to experience a different culture. Tourists are attracted to the cultural differences throughout the basin such as Omo and Mago National Parks and protected areas for many ethnic groups, including the Hamer, Karo, Mursi and Bodi. They still maintain traditional dress, ornaments and traditional way of life.

Picture 16: Camping Site along the Omo River

All towns and some villages in the Basin provide accommodation which may be classified into three types according to the standards of planning, construction, space and equipment - lodging houses, traditional hotels and hotels or camping. National Parks and some Basin tows have campsites.

3.3.11 Infrastructure and social services

3.3.11.1 Road Transport

The road network is generally in a very poor and rudimentary state. While most Wereda main centres are served by motorable roads, many Kebeles can be reached only by footpath and pack trails. However, population densities in numerous of these locations are often low and in many cases the terrain is dissected and mountainous.

The construction of permanent roads, within a Wereda, for the primary objective of improved Wereda administration and service provision, will rarely be economically justified.

In order to function effectively, the administration and service provision in the lower Omo must have improved road access. Materials and supplies have to be delivered, while money and information need to be efficiently transmitted.

Table 3.67: Roads status at Zonal level

Zone/ Sp. W	Length (km)	Asphalt	Gravel-Federal	Gravel-Regional	Earth and Earth Track	Earth	Earth Track
South Omo	710,3	0	412,8	126	171,5	19	152,5

Source: Omo River Basin Development Master Plan Study: Final Report

Picture 17: Mago Park’s road

The following table shows road distances of the 4 Wereda. The roads conditions are quite poor: even the main connection roads are not all-weather roads and can hardly be negotiated during the rainy season between June and September.

Table 3.68: Road distance of Wereda capitals from Zonal and regional capital

Wereda	Capital	Distance from zonal capital	Distance from regional capital
Salamago	Hana	118	643
Dasenech	Omorate	204	655
Nyangatom	Kangaten	160	600
Hamer	Dimeka	100	583

Source: Field survey made by MDI Engineering and Agriconsulting Spa

3.3.11.2 Rural water supply

Water supply schemes in the rural settlements of the South Omo are rudimentary. Less than 1% of the rural population has access to any form of a protected supply.

Water is collected from rivers, streams and ponds, the nearest natural sources that are available for each community. In the wetter seasons of the year such sources are often within short walking distance, less than 1 km. In the drier seasons, water may be carried from the nearest perennial source for as far as 10 km.

Water is commonly carried to the homestead by the women in large bottle shaped clay pots, slung in a bark harness worn on the carrier’s back. After rain it is common to see women bailing water from muddy roadside ditches into their water carrying pots.

Constructed village wells tapping into shallow aquifer with a concrete lining, raised wellhead, and masonry apron and windlass or rope-and-bucket system are very uncommon in the South Omo.

Some communities have dug self-help shallow wells, but these are usually unlined, have no wellhead and are liable to both infill and contamination.

In very few locations, NGOs have given priority to improving village water supplies and a sequence of protected wells have been developed within that NGO’s operational area.

The almost complete absence of clean, potable and perennial village water supplies has a very adverse effect on the health and physical fitness of the rural population. Infection by water-borne diseases and water-borne parasites is widespread.

A program of constructing hand-dug wells is essential to alleviate the village water supply problem in the South Omo’s Weredas. Watering of livestock is a second major use of village water supplies.

3.3.11.3 River transport

The Omo River offers some potential for the transport of both people and goods. The only use currently made of the Omo river navigation is by mean of small-scale commercial tourist operations and a few artisanal local fishery activities.

Omo River is not suitable for navigation by larger commercial vessels. Its course has frequent shallows and low rapids, and it also has a marked seasonal fluctuation.

These factors permit only shallow drought navigation. However, the central part of the Omo Basin is the most inaccessible part of the river’s catchments due to lack of roads.

Picture 18: Omo River at Omorate town, Government Ferry Boat

Furthermore, the irregular seasonal river flow, characterized by huge floods during the rainy season and very low water quantity during the dry season, does not allow desirable river use by local inhabitants.

3.3.11.4 Rural credit and financial institutions

Credit provision in South Omo Zone is extremely low and concentrated around urban centres. Credit is provided mainly through the formal institutional apparatus.

Informal sources of credit in the Zone are limited and characterized by small loans and high interest rates.

Table 3.69: Wereda's financial institutions

Wereda	Bank	Insurance Company	Micro-finance institutions
Salamago	2	2	2
Dasenech	2	2	2
Nyangatom	-	-	-
Hamer	2	2	1

1=Yes, 2=No

Service Cooperatives (SC) is the link between the financial institutions and the rural people with respect to the provision of credit facilities, while a part of the credit comes from relatives or friends.

The credit supply to women has traditionally been constrained because only the head of the household were eligible for the Service Cooperatives membership until the 1990s.

As a result, women generally accounted for between 5 to 15% of total members of SC. In order to pursue income-generating activities, women have depended on the extremely limited services available from the informal savings and loan groups. Therefore, the supply of credit to woman in the project area has been negligible.

There is a demand for credit by women for income generating activities and small enterprises including: fattening cattle and small ruminants, producing poultry, dairy farming, vegetable production, handicraft production and tailoring.

A host of difficulties have been associated with credit provision and control. Evidence shows that poor repayment occurs for a variety of reasons, including:

- Low yields and production levels,
- Low market prices and market accessibility,
- Low level of profitability, and
- Ineffective extension service.

The volume of credit available for the rural communities of the project area is the most limiting. Formal credit provision through the banking system for productive purposes is constrained and, in the case of non-farm credit, even absent. There has been a general reluctance on the side of the banks to open credit lines to peasant farmers.

This reluctance can be explained by a number of reasons. Firstly, the handling charges for processing small loans are relatively higher than for a larger loan; secondly, small enterprise operators generally are not able to offer sufficient collateral to satisfy the bank's lending conditions.

Where credit has been made available through the Service Cooperatives, problems of both timeliness in credit provision and inadequate checks and controls have been noted. In many instances seasonal credit has not been available on time and difficulties in repayment have occurred.

The following table illustrates the various uses of credit where food and medical treatment represent the more common of these. This kind of credit motivation can demonstrate the fragility of a household budget, often insufficient to cover ordinary expenses like nutrition and family health.

Table 3.70: Use of credit (%)

Region	Zone	Wereda	Inputs	Animal purchase	Food	Education	Medical treatment
SPNRS	South Omo	Salamago			90,9		5
		Dasenech		2,2	17,8		4
		Nyangatom		6,7	33,3	3,3	40
		Maji	38,7	12	28,7	11	10
		Hamer	29,5	22,7	27,4	2,3	17

Source: Field survey made by MDI Engineering and Agriconsulting Spa.

Some donor institutions and local and international NGOs are implementing micro-credit initiatives stand-alone or inside multi-sectoral programs supporting rural development.

Table 3.71: Development organizations and NGOs

Wereda	NGOs/donor	Project title	Main Objectives	Budget	Start year	End year
Salamago	GTZ	Borana Lowland Pastoral Development Program	- Promotion participatory implementation pastoral livestock dev and Extension Services Promotion of participatory management of rangeland resources		1996	2005
	SIM	Providing help for breeder community	To provide education facilities To provide health facilities To provide improved agricultural practice	2.160.206	2004	2009
Dasenech	GTZ	Borana Lowland Pastoral Development Program	- Promotion participatory implementation pastoral livestock dev and Extension Services Promotion of participatory management of rangeland resources		1996	2005
	Farm Africa	EBP (Ethiopian Breeder Program)	- Participatory risk management - Promotion of participatory basic development services		2005	2008
	EPARDA	Develop and Improve the pastoral life	- Promotion of health service - Promotion of conflict resolution			
	Catholic Church	Integrated community development project	Promoting health service Promoting education service			
	Refugee Trust International		Participatory natural resource management		1998	2005
Nyangatom	GTZ	Borana Lowland Pastoral Development Program	- Promotion participatory implementation pastoral livestock dev and Extension Services Promotion of participatory management of rangeland resources		1996	2005
	EPARDA	Develop and Improve the pastoral life	- Promotion of health service - Promotion of conflict resolution			
Hamer	EPARDA	Develop and Improve the pastoral life	- Promotion of health service - Promotion of conflict resolution	2.718.000	2006	2009
	IFAD	International food association development	To build the capacity of breeders by irrigation To build the capacity of women by training To provide agricultural input for the community	474.548	2001	On going
	Farm Africa	EPP (Ethiopian Breeder Program)	- Participatory risk management - Promotion of participatory basic development services	491.763	2005	On going

Wereda	NGOs/donor	Project title	Main Objectives	Budget	Start year	End year
	AFD (Action for development)	To revitalize the livelihood through provision of agricultural inputs	To build the capacity of people by training on basic skills and techniques of early warning system		2004	On going
	Catholic Church	Integrated community development	To introduce new technology to the society To train women how to work on the introduced technology	6.859.317	2004	2009

Source: Field survey made by MDI Engineering and Agriconsulting Spa.

3.3.12 Archaeological and Cultural Sites

Hominid fossils un-earthed / exposed in the Upper Turkana basin, including those of the Lower Omo, comprise both the relatively recent *Homo sapiens* as well as Plio-Pleistocene remnants of one or more (according to different debating scientists) species or sub-species of ancient *Australopithecus robustus / afarensis*.

As far as the latter are concerned, recent theories (M. Leakey, A. Walker, National Museum of Kenya, Scientific American n. 14, 2003) suggest that above early hominids inhabited the entire area occupied in those times (0.8 - 4 million years ago) by the woodlands and savannahs in the immediate proximity of the ancestral paleo-Omo river, which flowed from the Abyssinian highlands straight to the Indian Ocean.

Under this scenario, for much of the Pliocene, and early Pleistocene (F. Brown, Utah University; C. Feibel, Rutgers University) the paleo-Omo was the major agent of deposition / sedimentation in a huge area (see following maps), within which the presence of the Turkana lake, which nowadays has no outlet, was quite uncommon and could have been regarded as temporary, or infrequent, within "an extensive river system which flowed across the broad floodplains, proceeding to the Indian Ocean".

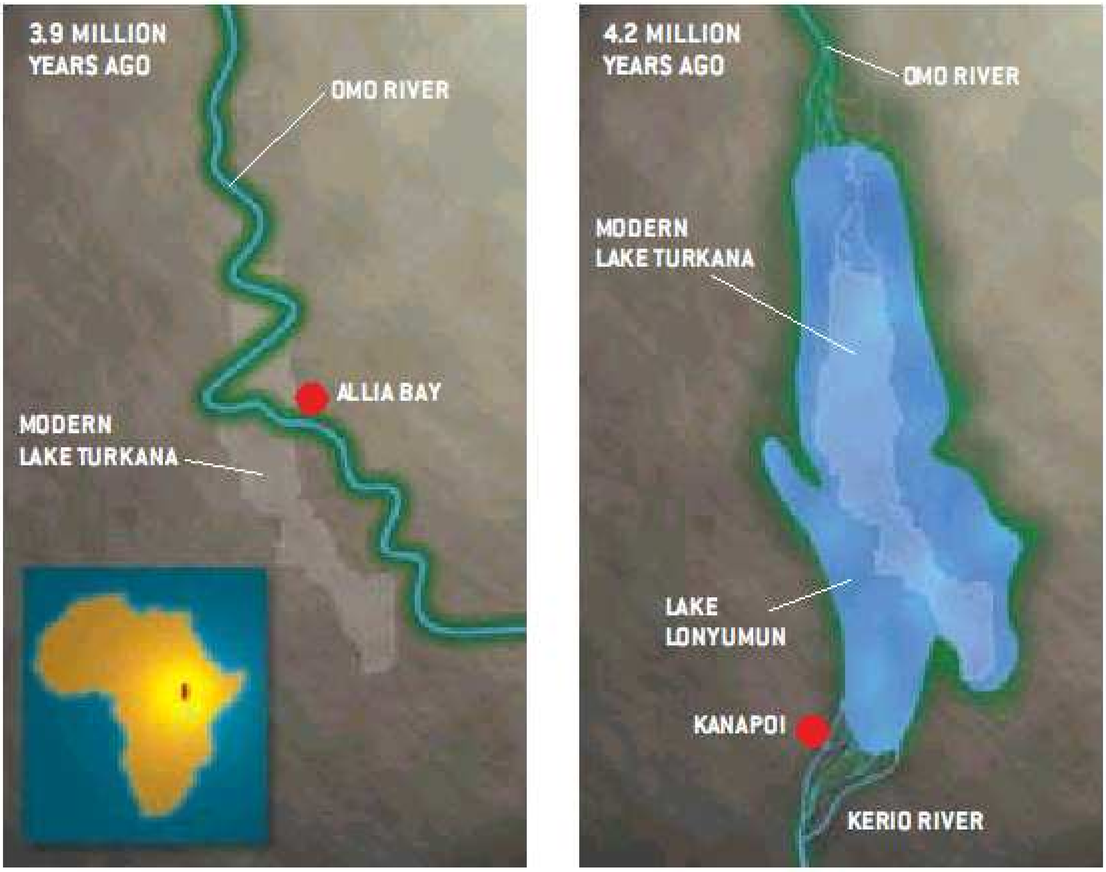


Figure 3.19: Omo river basin at Turkana

In fact, all down its ancestral valley, early remnants have been discovered both in Ethiopia and Kenya (eg, Allia Bay, on the Turkana shores) along the main ancient directrix of the system from Omo down to Kanapoi, at the beginning of the Kerio Valley.

In the current Lower Omo, hominid remnants have been identified in a number of different locations belonging to Pleistocene geological formations which have been termed according to tribes, areas, or villages (some of such terms superimposable to a certain extent) such as Shungura, Useno, Kibish, Mursi, and Konso, with above names sometimes representing names of tribes, some other of Villages (or both) of the Lower Omo plains.

For what concerns, in particular, the Kibish formation (placed on the west banks north of Kelem, near Chibele village) includes human fossils some of which were discovered by Richard Leakey in 1967 “to the north west” of Omorate, this has shown to contain individuals of *Homo sapiens* some 195,000 years old.

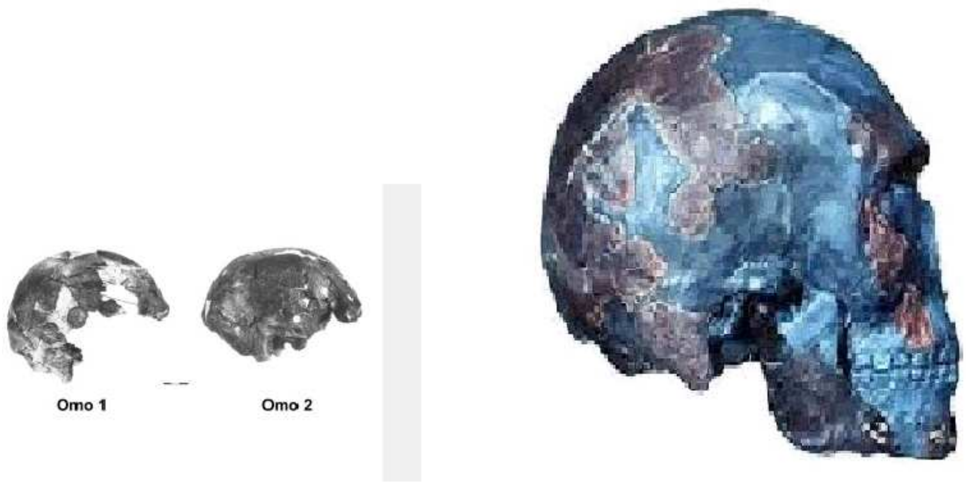


Figure 3.20: R. Leakey *Homo Sapiens* "Kibish" Skulls (reconstructed)

This and other findings in the same area representing the most ancient modern human (*Homo*) discoveries in the world, that were laid down in a deltaic environment associated with the Omo river where it entered lake Turkana, which was already in existence, though much more extended than now (perhaps more than 100 km north), as testified by unusual distinctive sediments (sapropels) within the same formations, characteristic of environments of low oxygen conditions.

As said, in many instances being the prevailing socio-anthropological context locally characterised by non-sedentary tribes, the very same concept of "Village" (and therefore its name) does not represent a unequivocal entity, but rather the indication of one or more "places where our people at present are"; thus explaining the presence of several villages / areas with the same name (Turmi, Kibish, etc).

This has meant a certain degree of confusion in tracing back on the ground a number of exact spots of past paleo-anthropological findings until the occurrence of the modern GPS techniques.

Together with the confusion in toponymy, and exact locations, it would appear that, at least for the Kibbish *Homo* skulls, these formations would seem to be intermixed with Shungura formations yielding more ancient *Australopithecus* remnants in a wide area somehow placed on the western banks of the Omo delta, south and north (mostly) of present day Omorate town. This occurrence is perhaps the result of volcanic activities bringing to surface lower strata amongst old river alluvium.

The entire area has however been the subject of a World Heritage Site being established by UNESCO, of an unknown / unclear extent and location, whose (presumed) centre had been marked with N4 48 E35 58 co-ordinates, more or less corresponding with the village of Kelem, on the West Bank, just north of the Turkana lake.

For what concerns other cultural values of the Lower Omo, this is home of different ethnic groups with their diverse culture and cultural heritages in the form of both tangible and intangible features include different landscapes, wildlife and natural sites of outstanding and universal value from the point of view of human, animal and plant science studies as well as being a pole of tourist attraction.

The people of the valley are also endowed with intangible cultural heritages, which include performing arts such as traditional dance, music, and style of dressing.

Further, the people of the valley are well known for their performance of different social practices, ritual and cultural festivals that are considered amongst the most peculiar worldwide. Each ethnic group has also oral tradition, expression and culture of traditional craftsmanship which are further discussed within the appropriate Report section.

4 ENVIRONMENTAL IMPACTS

4.1 Project Benefits

4.1.1 Beneficial impacts on physical environment

4.1.1.1 Water resources

The main beneficial impact of the project on the Omo-Gibe River Basin's water resources resides in its contribution to the regulation of the downstream hydrological regime, especially in the river delta.

In broad terms there will be an increase in the flows during the dry season and a reduction of the flows during the rainy season, when the water is retained to fill the reservoir.

The most relevant beneficial effects will occur during the highly rainy and dry years.

The current hydrological regime, modified by the deforestation of the upper watershed, shows frequent critical events in the river delta having:

- Large and sudden floods (peak flows up to 5200 m^3/sec, return period 30 years, Gibe III site);
- Extended drought periods (August average flows down to 820 m^3/sec, year 1987, Gibe III site);

Floods occurred in 2006 (with return period of less than 10 years) caused destructive effects on human and animal life, private assets and public infrastructure in the river delta, while the extended droughts period 1986-1987 originated a famine crisis for humans and wild life.

The plant will allow the complete regulation of the river flows reducing the highest peak floods and avoiding extended drought periods by means of:

- The reservoir live capacity of 12300 Mm^3
  (Comparable to the mean annual inflow volume of 13.800 Mm^3);
- The large outlet works
  (Two middle outlet with Q_{max} = 1080 m^3/sec each, one ecological outlet and nine spillway radial gates);

The outlet works are planned to guarantee a remarkable flexibility of the plant operation.

The discharge rules can be adapted following the requirements both of the energy production and of the downstream environment.

The following graphs illustrate the comparison between the monthly flows (at the Gibe III site) before and after the dam construction based on the most significant operating scenario envisaged.

The analysis considers the discharges recorded during a 38 years period (1964 - 2001) simulating the operation of the plant.

The graph below shows the average flows (38 years period). The subsequent graph shows the maximum discharges of a highly rainy year (year 1988).

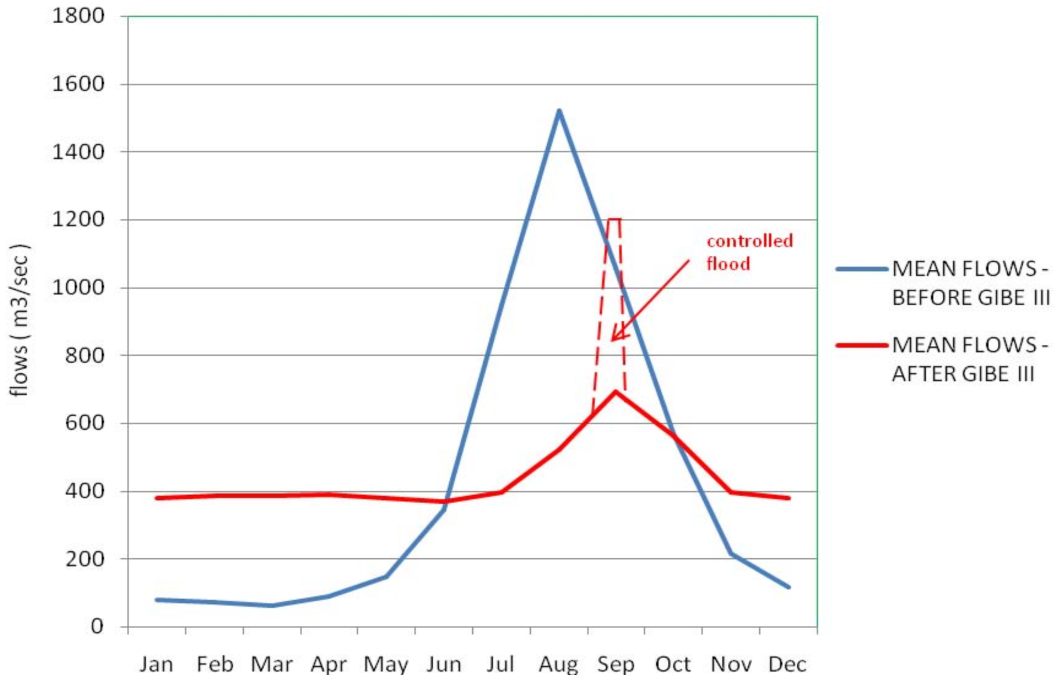


Figure 4.1: Monthly flows at Gibe III site: average 1964-2001

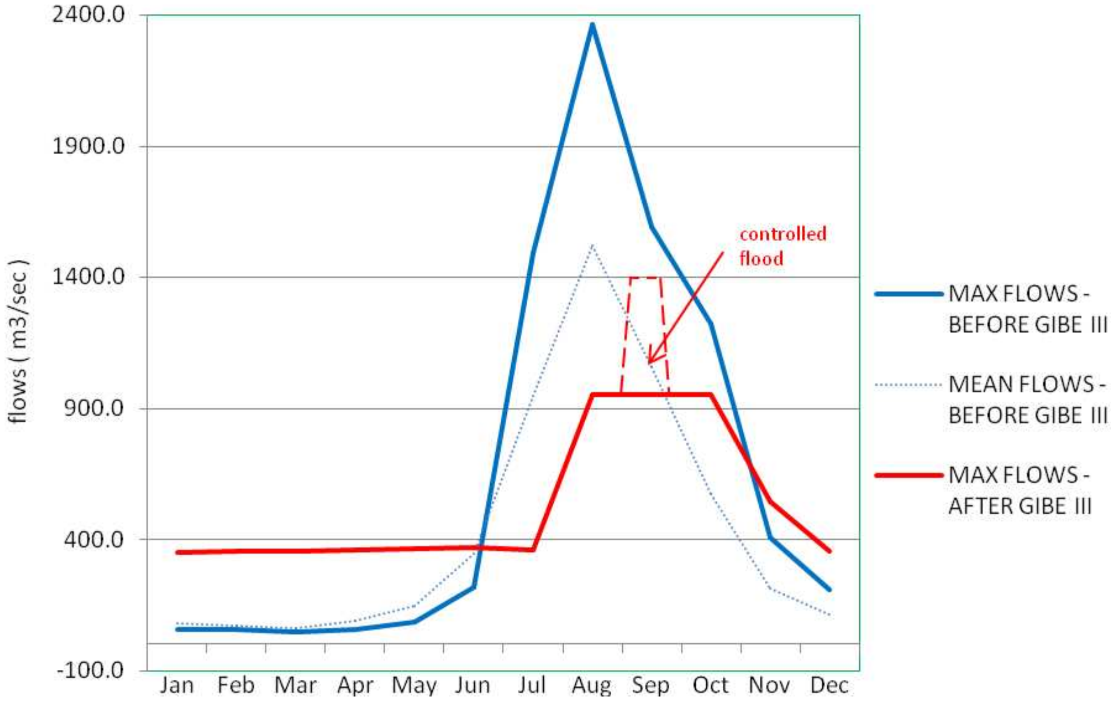


Figure 4.2: Monthly flows at Gibe III site: year 1988 (max flows)

Average flows during the month of August currently range from 820 m^3/sec to 2360 m^3/sec (Gibe III section, 38 years flow records).

While operating the Gibe III plant the complete regulation of the downstream releases is allowed by the turbine outflows, up to a maximum of about 1000 m^3/sec, together with the large outlet works discharges.

A controlled flood is foreseen from the reservoir during the months of August / September to coincide with the peak flows from the residual basin.

This release is intended to limit the downstream flooding to the required extent, in duration and in areas, while reproducing the natural average flooding conditions.

As illustrated in chapter 5 the planned discharge from Gibe III Hydroelectric facility will have the same magnitude of the average-year maximum flows on the Omo river downstream stretch.

While moving downstream along the Omo River, towards Lake Turkana, the effects of the Gibe III flow regulation decrease following the contribution of the discharges from the residual basin.

The graph below shows the average flows of the Omo River at Lake Turkana (38 years mean). The subsequent graph shows the minimum discharges of a highly dry year (1988).

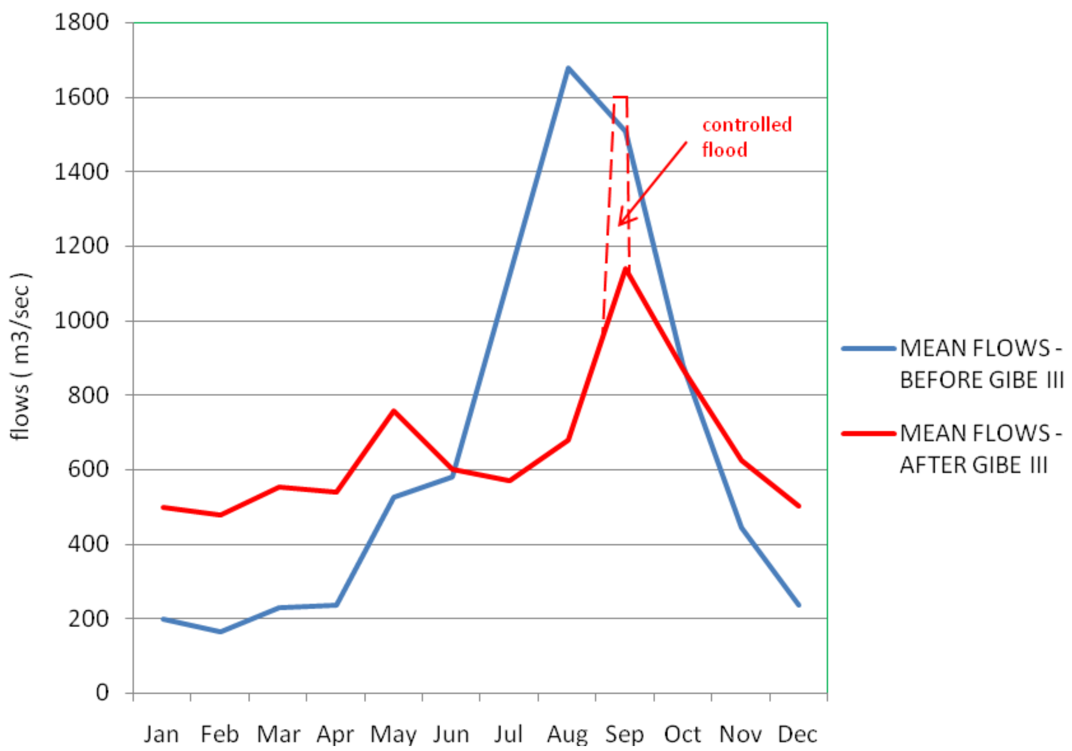


Figure 4.3: Monthly flows at Lake Turkana: average 1964-2001

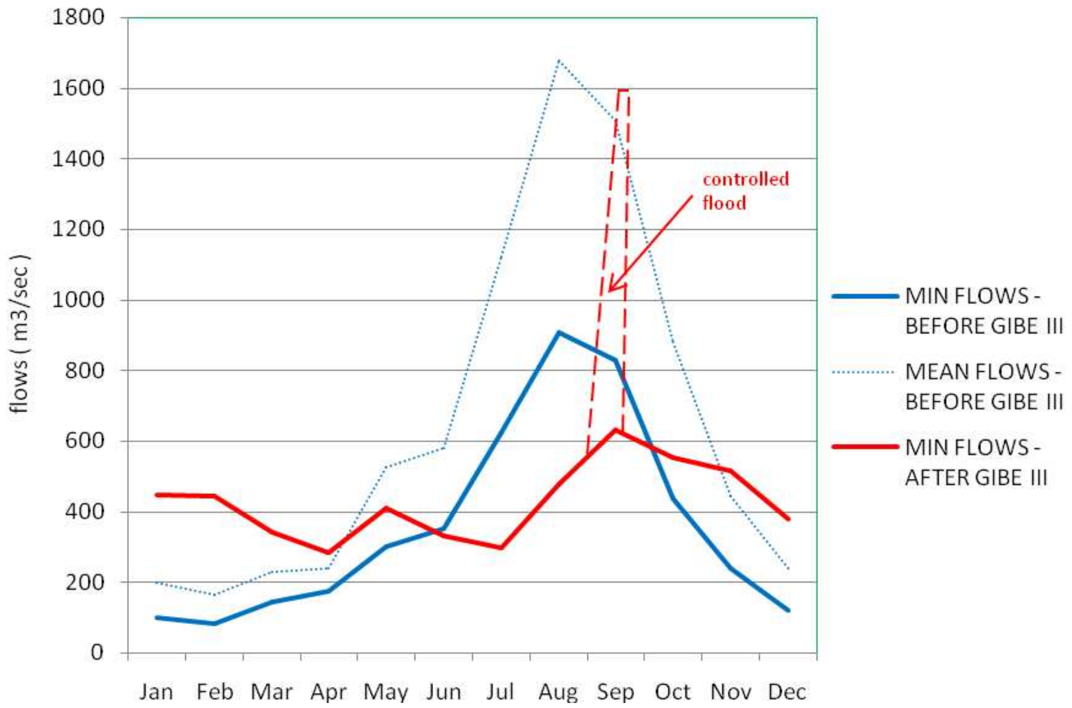


Figure 4.4: Monthly flows at Lake Turkana: year 1987 (min flows)

The long-term benefits will include the reduction of the unproductive evaporation losses taking place in the floodplains after the floods retreat.

These losses largely exceed the expected total evaporation from the proposed Gibe-3 reservoir.

The water surface when the reservoir is full is about 210 Km^2 while average temperatures are about 20°C (annual mean), varying between 15°C and 30°C, with a rainfall in the range of 1300 mm.

Compared with the total area of the Lower Omo River Valley's unproductive marshlands (about 80 square Km), and the extremely hot and arid climate of that region, with total rainfall less than 500 mm, the evaporation losses from the proposed reservoir appear negligible.

Evaporation losses in the swampy depressions of the floodplains are particularly relevant in extreme high-flow years when the magnitude and duration of the floods also causes disastrous effects on the communities. In contrast, no appreciable evaporation losses take place in the low-flow years when the Lake Turkana system suffers however from serious hydrological deficits.

The regulation of the river flow will also induce a more efficient use of water resources, by providing reliable and timely water supply during the year, for the traditional flood-recession agriculture on the riverbanks.

The increased average terminal runoff will therefore benefit the hydrological balance of Lake Turkana. The lake represents obviously a major asset in the region not only for evident environmental reasons but also for the fishery and tourist activities.

Due to the decreasing inflow from the rivers feeding this inland-contained hydrological system, the levels of Lake Turkana shows a worrying marked tendency to decrease with its surface area consequently gradually shrinking in the medium - long term. This results in the perceived progressive retreat of the shoreline that implies the reduction of the exploitable waters for the Ethiopian fishing boats fleets.

The regulation of the river flows induced by the Gibe III dam, reducing the evaporation losses, contributes to re-establish a positive hydrological balance in the Turkana transboundary system. This is in fact the long-term objective jointly pursued by the riparian countries through high-priority dialogue and negotiation, for the system to be restored to the equitable benefit of the people relying on lake resources.

The main beneficial impacts of the Gibe III reservoir operation on the downstream hydrological regime are therefore as follows:

- Control of the large and sudden floods occurring during the wet years (up to 5200 m^3/sec at Gibe III with a return period 30 years);
- Reduction of the extended drought periods (as the 1986-1987 ones);
- Reduction of the evaporation losses which contribute to the current recession of the Lake Turkana;

The large flexibility of the plant, due to the substantial live capacity and outlet works, allows modifying the operating rules of the reservoir following the requirements of the energy production and of the downstream environment.

4.1.2 Beneficial impacts on the biological environment

4.1.2.1 Wildlife and other terrestrial fauna

As previously mentioned, riverine areas represent refuges, though often of a temporary nature, for birds, invertebrates, reptiles, amphibians, ungulates and primates, species of which utilise the area for shelter, breeding and hatching.

During floods, much more for those of a long and devastating nature, such animals are forced out of riverine habitats.

In fact, from a mere biodiversity point of view, the periodic and constant yearly occurrence of sustained catastrophic events, such as excessive ranges in flow (and related differences in water speed and turbidity) and major floods of excessive duration, greatly limit opportunities of many terrestrial (and some aquatic) living organisms to establish themselves in the river proximity.

In this sense, reduction (control) of floods and more constancy in river flow throughout the year as it may be anticipated after construction of the Gibe III Hydropower plant may play a positive role for local animal biodiversity, particularly for terrestrial micro-mammals of riparian habitats.

It has further been noticed by Park personnel, and reported to the Mission that in periods of river dryness, limited presence of shallow water and ponds generates high degrees of competition amongst river wildlife, particularly crocodiles and possibly hippos which start fighting amongst each other for territory.

In the presence of more regulated river flows allowing sufficient presence of water all year round, such territorial competition may most likely diminish or cease altogether.

4.1.2.2 Terrestrial flora

Reduction of excessive flooding, especially in terms of its duration, within riparian forests and other formations will in most cases be beneficial to floral biodiversity, with an increase in the overall number of species including those presently sensible to prolonged periods of submersion.

The herbaceous stratum will also benefit from more limited flooding, increasing its photosynthesis activity and establishing itself on the river banks down to the river stabilised water level, thus contributing to limit riverbank erosion and filtering sediments reaching the river from the interior.

In fact, in studies carried out within flooded areas of central Amazons it has been ascertained that flooded areas within riverine and stream habitats displayed species richness and diversity negatively correlated with water levels and duration of flooding. The (comparatively) dried habitat of riverine formations, in fact, had more total and unique species than those submerged for considerable periods of time.

4.1.2.3 Fish stock and resources

Regulation of the river flow and provision of timely and adequate artificial floods and environmental flows as planned will enhance the existing potential to develop commercial fisheries in the downstream Omo River and Lake Turkana.

Such activities are presently limited by excessive river fluctuations and occurrence of catastrophic events hindering year-round regular access to fishing and landing sites, infrastructures, fishing vessels and modern gear, etc, hence fishing along the river channel and in the floodplain has been rather limited to a subsistence fishery (mainly for home consumption).

However, unlike other rivers (except the Baro) the Omo River contains fish stocks of high quality and species diversity and abundance at low altitudes. Its link to the Turkana Lake is also very significant for the fishery as the estuarine areas and river delta are very productive with suitable fishing grounds.

As mentioned above, the fish resource in Lake Turkana is almost untapped in the visited project area. This could be seen from the large size (and apparent old age) of Nile perch observed at the landing sites.

Therefore, income improvement and social development plan in the fishery sector has been identified and proposed. The plan will be taken by EEPCO in partnership with regional and local governmental and non-government agencies and institutions. By implementing this plan:

i) Both riverine and lake fishery will be advantaged and will have the opportunity to efficiently develop technical skill, fishing materials, infrastructure, processing, storage, transport and fish market facilities, provided the river overall productivity is sustainably maintained by proposed mitigation actions.

ii) Strong extension service and credit facilities will be made available to encourage and enhance the programme implementation. Through this extension programme, the fishing community could be trained in better handling and processing fish to an export standard especially for high valued fish like the Nile Perch and earn much more than selling at the local market.

iii) Introduction and promotion of fish culture is another area of development that is potentially viable. There are many fish species that are suitable candidates for the purpose. The climate, the land and water are all there but the technology and the initiative are lacking at the moment. Hence, first by developing the fish market the fish culture programme could be initiated and promoted.

iv) The fishers will further have the opportunity to develop small-scale river-based tourism operations such as renting out boats, guiding the sport fishing tourists on the water and through initiating local fish restaurants and the like. Tourism will be promoted through sport fishing activity as part of the community tourism initiated by the National Park.

4.1.2.4 Fluvial and lacustrine biodiversity

Aquatic vegetation, therefore biodiversity may increase as a consequence of more regulated river flows and consequently stabilised riverbanks.

This was shown, for example, in nearby areas after development of the large Turkwel River Dam, which has also significantly changed the flows of the Turkwel River, once reaching the west shores of Lake Turkana Lake in Ferguson’s Gulf.

In this case, aquatic vegetation has increased in the delta area, with the delta now permanent wetlands potentially maintaining or increasing the biodiversity of fauna and flora both locally and regionally -while also attracting permanent human population most likely in conflict with flora and fauna- (Haack and Messina, 2001).

Increased permanence of water within the river and the delta will also provide a more protective habitat for some endangered haplochromine species, as well as for macrofauna such as hippopotamus and crocodiles, together with snakes, birds, invertebrates such as snails, and insects (eg. mosquitoes).

Improved regularisation of water flows within the delta may further play a role in constantly reducing intrusion of saline water of Lake Turkana into delta aquifers, thus increasing fresh water availability in that particular habitat.

4.1.2.5 Protected Areas

Tourism Development, and therefore Park revenues, especially for the Omo National Park will undoubtedly receive a considerable boost by a certain degree of regularisation of river flow in terms of enhanced opportunities for Park management and private investors.

Such opportunities may be expressed through establishing sustainable eco-tourism enterprises along the river (safari camps, wildlife / birdlife watching sites, trekking, etc) and within it (rafting, boating, canoeing), thus generating local employment opportunities and contributing to environmental friendly local development.

Construction of bridges and pontoons in selected locations will be made possible, as riverbanks will become more stabilised. This will bring about infrastructural and road / track upgrading, consequently increasing eco-utilisation of the Omo Park interior while strengthening Park Management capabilities to deal with nature conservation and patrolling activities.

4.1.3 Beneficial impacts on socio-economic environment

4.1.3.1 Agriculture

One of the immediate benefits of constructing the Gibe-3 dam will be the ability to avoid severe drought periods and to control the large flooding downstream which cause the loss of lives, both human and animal, as well as damage to property and infrastructure. However it is recognised that a complete cessation of the average annual floods would be disastrous for the communities, which practice flood recession agriculture.

The Project has thus allowed for controlled flooding to enable the traditional way of life to continue.

A reliable, regulated river flow taking place for the most part of the year will encourage investment in irrigation to produce food, fodder and cash crops.

At present, irrigation infrastructure is frequently damaged by floods and the land is often inundated for weeks at a time. Farmers and companies are not investing in permanent pumping stations because of this and as a result, most irrigation is limited to low capacity portable pumps.

A more regulated flow in the river will also ensure adequate water levels at all times of the year, whereas at present, dry season river levels are often too low for pumping efficiently, particularly in the recurrent years of drought.

Irrigated agriculture will also provide the basis for more settled developments and although it is recognised that the traditional pastoralist way of life will undoubtedly continue under the enabling conditions created by the induced controlled flooding, it might develop somewhat in the long term, from being almost wholly nomadic, to semi-nomadic.

Flood control will make it possible for permanent settlements to be built on the river banks, without fear of them being devastated, thereby making it possible for people to benefit from education, healthcare, veterinary services, trading, markets, etc. Access roads will be constructed, which is impossible at present because of the floods.

Concerning the beneficial impact on agriculture, field surveys confirmed how the present Omo River flow is on the one hand vital for agricultural production, but on the other hand surveys clearly show how uncontrolled large floods as well as drought periods are negative for agricultural production.

Chapter 2.3.5 underlines how a good percentage of agricultural production is lost for different reasons like drought, insects or animals as well as because of large floods.

Cash and food crops production losses due to excessive flooding are definitively a negative aspect that will disappear as a consequence of both river stabilization and controlled floods.

4.1.3.2 Livestock

The Omo River displays different degrees of importance for the respective Weredas that it crosses. Similarly, the construction of Gibe 3 along the Omo River will have relatively varying effects on livestock production in the different Weredas.

In upstream Weredas, the importance of the Omo River is mainly in the provision of drinking water for cattle in the dry season, as very limited, if any, natural pasture benefits from river flooding. Yearly higher levels of water within the riverbed will facilitate access to (and increase the number of) river watering points available to cattle.

Downstream Weredas and communities will, on the other side, mainly benefit from secured released flooding limited to mean annual values, ensuring that more defined and identifiable grazing lands will be available for transhumance seasonal grazing while avoiding dangerous and destructive excessive flooding in wet years.

Also, providing for minimum required flooding in extremely dry years thus providing a good degree of security for pastoralists undergoing transhumance from the highlands and inland territories.

Knowing in advance where to bring their cattle and timing of seasonal pastures within floodplains will help in reaching permanent agreements between the different ethnic groups thus avoiding sources of conflict often due to sudden and unplanned invasions of territories of influence of specific tribes.

Moreover, the devastating effect on the livestock herds due to the extreme high-flow years will be avoided, as the dam will laminate such extreme events, so as to limit the flooding to the acceptable extent only. This will bring a major, two-fold positive impact that needs to be taken into account as a very important project benefit.

Eventually, within Dasenech Wereda, Omo river delta islands presently inundated and not accessible to any livestock or humans for considerable periods of time, will be subject to further increased animal utilisation as grazing lands due to reduction of the overall flooding time compared with the present unnecessary lengthy periods, while natural pasture potentials will also increase due to higher watertable levels and decreased incidence of waterborne diseases.

4.1.3.3 Social services, facilities and infrastructure

The project will make significant potential beneficial contributions concerning Social Services, Facilities and Infrastructures.

Beneficial aspects will emerge by uncontrolled floods reduction due to the new and more stabilized Omo River flow.

Beneficial aspects will include the potential for improved communications in downstream Weredas that will allow all-year transportation of people and goods, and improvement of river navigation for small vessels due to the regulation of the river flow on sufficiently high levels and reduction of small-scale irrigation schemes damaged by uncontrolled floods.

Increasing communication (Rod Transport) in downstream Wereda: Notwithstanding the extensive weaknesses of the road transport system in the South Omo, GIBE III hydropower dam project could have beneficial impacts on increasing intra and extra Wereda communications.

The heavy and frequent seasonal floods constantly damage the hearth road system in the most remote zones, adding obstacles and making it difficult to connect for a large part of the population, which remains isolated up to 3-4 months a year.

The extent of such unforeseeable catastrophic events also renders impossible construction and maintenance of communication bridges across the river.

Regulation of the Omo river flow will avoid heavy floods and consequently will more easily allow connection for people and the exchange of goods.

Improvement of River navigation: Regulation of the Omo river flow will have a beneficial impact on the river flow navigation, contrary to the present state where river navigation is very limited if not impossible.

Lightweight riverboats using the river as a natural highway into these remote areas will offer a more cost effective alternative for transporting people and lightweight supplies. Field trials of lightweight river crafts could then begin.

The use of such lightweight powered river craft will allow access to some isolated Wereda like Salamago, Maji and Nyangatom, which have not previously considered the possibility of using the river system to service Kebeles within range of the Omo and Gojeb rivers. There may be some initial cultural resistance to the concept until its potential has been properly demonstrated and accepted.

Trade: A consequence of the river regulation as well as foreseeable improvement of roads and river navigation will certainly have a beneficial impact on trade and local commerce.

In fact, the only way to increase intra-Wereda commerce is to facilitate communication, market contacts and access to Credit and Extension Services for farmers and breeders.

Arrangement needs to be made by lending institutions to provide rural communities with convenient access to credit. For example, mobile banking services for residents in the rural area could be introduced, and credit officers could be recruited and trained to inform and assist loan applications.

In a country where drought has often had a very profound impact on the domestic food supply, there should be no impediment to inter-regional trade, as this provides a mechanism to moderate the effects of regional food imbalances.

A substantial investment in the rural infrastructure is required to allow freer markets to distribute inputs and receive marketed surpluses. Improved infrastructural and marketing facilities will also be required to improve the possibilities for the rural poor to diversify their income generating opportunities.

This is one of the key factors to survival and the building up of assets over the longer term, in fragile and disaster-prone environments.

4.1.3.4 Archaeological and Cultural Sites

Discovered and potential Paleo-anthropological sites of interest within the mentioned formations involve a vast area of the Lower Omo, where geomorphologic features such as depressions, old Omo branches and meanders, dry tributaries riverbeds, etc have exposed hominid remnants, due to cyclical fluctuation in the development of local river systems, within a large territory that is all potentially equally important.

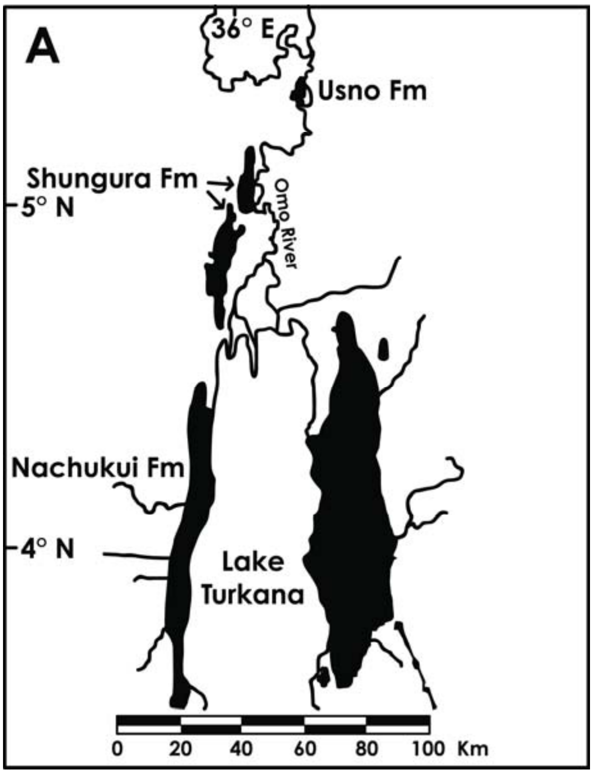


Figure 4.5: Location of Shungura and Usno formations

In fact, one of the few sites being placed “by the river” (in its actual location) is the 1967 location that yielded the two fossilised skulls (Omo I and Omo II) of the Kibish formation, although in 1999 and later on the same team of palaeontologists under Dr. Leakey recovered a number of hominid bones within the same formation on a much wider area, together with remains of other animals and stone tools, further inland.

All in all, about 900 places within about 75 square miles of old beds have yielded fossils, in all different sorts of environments, including ravines, eroded hillsides, and similarly exposed areas.

In such a composite, diverse, and equally important environment, the eventual regularisation of river flows as a consequence of Gibe III Hydropower development, by mainly confining river waters within the present river bed is likely to be a positive factor as far as paleo-anthropological and archaeological aspects are concerned.

On the one side, in fact, potentially interesting territory belonging to the more riverine portions of formations (Shunguna, Usno, Kibish) and related tuffs will not be subject any longer to prolonged period of submersion and destructive floods, thus rendering them available for exploration for longer periods of time, and with a low degree of risk for men involved in research as well as for unearthed materials.

Advanced knowledge and information on the planned controlled flood (duration, timing and its planned levels –extent-) will moreover represent a security, and a stabilising factor in planning further excavations and scientific research (for example within areas not likely to get flooded any longer in the event of recurring / natural excessive floods).

A stabilised river flow will encourage exploration on the main Shungura and Kibish formations (chiefly placed on the river west banks) by facilitating access to the same due to more stable river crossing opportunities.

4.1.3.5 Public health and safety

The Lower Valley of the Omo River is severely affected by major threats to human and animal health, represented by the high incidence of water-borne diseases, which are also a major constraint to economic development and poverty eradication.

The most common diseases throughout the study area are directly related to inappropriate water management and lack of hygiene. They include upper respiratory tract infections, malaria, schistosomiasis, onchocerciasis, guinea worm, yellow fever, trypanosomiasis, leishmaniasis, helminthiasis, dysentery and diarrhoeal, skin and parasitic diseases.

Trypanosomiasis besides menacing human health represents the major obstacle to the development of the livestock sector due to high prevalence of the tsetse fly in and around the vast depressions flooded by the Omo River right before the dry season that drives the nomad herds in these areas for drinking water and pasture.

Uncontrolled floods create dry-season swamps that largely exceed grazing requirements and are not accessible throughout the limited period the herds spend around these areas anyway, due to the tsetse challenge. These swamps are neither suitable for agriculture, nor for grazing purposes, and yet pose a serious threat in terms of a favourable breeding environment for a number of human and animal infection vectors.

Malaria is by far the most common and lethal disease, and similar to the other endemic infections mentioned above, less of concern to the Health Authorities. It mainly originates from and is sustained by lack of water management practices and water logging occurrence. The nefarious role of marshlands does not need to be emphasized in respect of spreading of water-borne diseases.

Access to safe drinking water is also frequently disrupted by the large catastrophic floods, and often also in the years of drought. These same impediments are experienced in the livestock sector, with insufficient veterinary facilities and services, and lack of infrastructure.

Based on the above, the consultant believes that the Gibe-3 reservoir, once the dam will be put into operation, will produce by itself some major beneficial effects in terms of public health, though partial and not *per se* decisive.

The special annual release planned in coincidence with the peak-flow from upstream of the reservoir will be limited to meet the actual requirements of the traditional recession agriculture and livestock seasonal pasture grass renovation, including in dry years where flooding would not have occurred but through the release itself.

This lamination will limit the loss of valuable water resources (see relevant section) in unproductive swamps from where most water-borne diseases originate, so helping to keep under control a number of endemic infections among which are malaria and trypanosomiasis.

By compensating the low-flow events the release will also allow for more reliable and safe water supply, not a secondary condition for effective health care, and secure an adequate nutrition level through sustaining recession agriculture and grazing resources in those unfavourable years of drought.

Infrastructure including shelter and roads will also be protected from the disastrous floods in years of extreme high-flow of the Omo River, with positive effects on the timely access of the dispersed populations to the existing Health Centres and Stations.

Similar beneficial effects will be induced in the livestock health and sanitation sector, in terms of:

- more effectively challenging the trypanosomiasis' disease by dramatically reducing water logging from uncontrolled flooding,
- securing reliable drinking water points both along the river and at the traditional off-stream seasonal reservoirs regularly fed by the controlled annual river-bank overflow, and
- facilitating access to veterinary services and public intervention in case of need, through a well-preserved network of communication and transport.

As for public safety, the benefits of having the dam in operation appear unquestionable.

Hydrological records show that under the erratic rainfall multi-year distribution the Omo River poses overwhelming sufferance to the population through disastrous floods roughly every 5 years on average.

During these relevant and yet recurrent events, losses of infrastructure, assets, animal and human lives can reach levels that call for extraordinary measures of National and international emergency.

According to the prevailing advice of the large number of Government Officials, Park rangers, farmers, women, migrant pastoralists, individual and associated fishermen interviewed in the project area, Omo River floods though beneficial in many ways in normal years may severely disrupt economic and social life in case of extreme both high-flow and low-flow events.

In August 2006, Omo River flash floods left 364 people and 3,000 animals dead, 15 villages washed away, 15,000 displaced people having their houses destroyed, damage to public and private infrastructure worth some 17 m USD, of which 10 m USD in the agricultural sector.

These figures are indicated as provisional in the appeal of the Government of the Southern Nations Nationalities and People Regional State, since helicopter rescue was still going on and 6,000 people had not been reached yet in 4 affected villages, Nyangatom and Dasenech Weredas, at the time of the Government press release.

Apart from the recurrent cost of such unavoidable interventions, there is high concern in the country for these catastrophic floods and the social distress they imply.

The multi-year regulation of the Omo River flow, by keeping the Lower-Valley flooding within the actual requirements of the riparian populations (recession agriculture, fishing, fluvial forest and grazing resources) will help ensuring that floods of such disastrous effects are avoided in the future, and more dignifying living conditions made possible for local populations.

4.2 Project Impacts

4.2.1 Impacts on physical environment

4.2.1.1 Water resources

The regulation of the flows envisaged by the Gibe III plant operation will have, especially considering multi-year periods, several positive impacts on the Omo River water resources balance.

The potential negative implications of this regulation of the flows have been assessed in detail and relevant mitigation measures envisaged.

As illustrated in chapters 2 and 5 a controlled flood is foreseen from the reservoir during the months of August / September to coincide with the peak flows from the residual basin.

This release is intended to limit the downstream flooding to the required extent, in duration and in areas, while reproducing the natural average flooding conditions.

The basic operational rules of the plant envisage 11 hours of production per day during which the installed turbines will discharge about 800m^3/s downstream of the dam.

The following graph illustrates the duration curve of the discharges while the plant is fully operating.

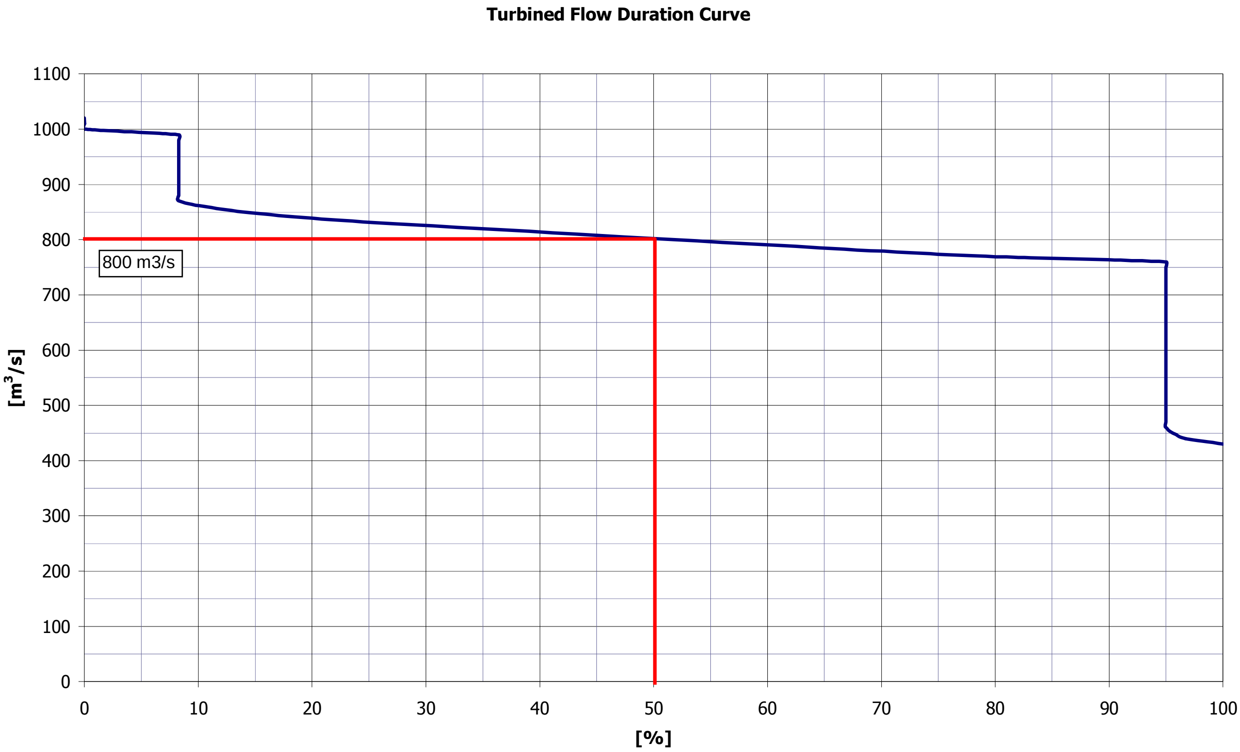


Figure 4.6: Discharges duration curve (38 years simulated period)

During the remaining 13 hours releases from the turbines will usually be small, probably ranging from 0m^3/s to about 100 m^3/s, depending on the future requirements of the energy demand.

A daily fluctuation of downstream water levels will occur as common for most hydropower plants.

The propagation of this "wave" has been modelled by the Project Engineer using HEC-RAS v.4.0 software (US Army Corps of Engineers). River topography derives from Shuttle Digital Terrain Modelling.

The figure below illustrates the modelled stretch, which starts from the Gibe III site and ends at the delta about 750 km downstream.

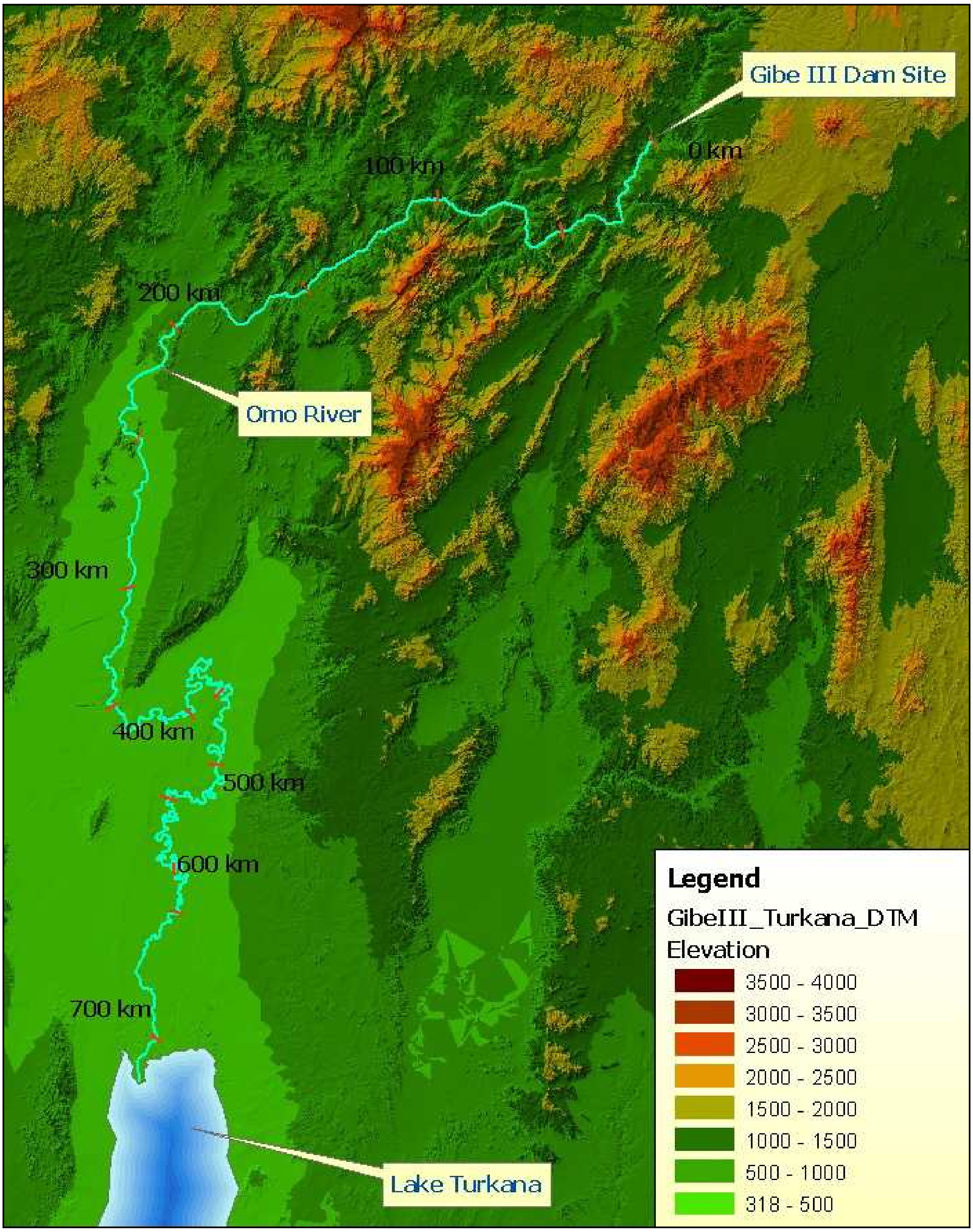


Figure 4.7: Omo river stretch considered in the hydraulic model

The discharges from the residual basin increase the minimum flows reducing the variations in the water levels.

Therefore the most severe condition has been considered by the Project Engineer in the analysis modelling by taking into account the dry season when the contributions from the residual basin are smaller.

During the wet season daily fluctuations of the water levels are remarkably less pronounced.

The routing effect, moving downstream towards the Lake Turkana, progressively regulates the daily variation of the flows.

The river flows through four distinct geomorphologic sections, as illustrated in chapter 2:

- Chainage 0-200 km: “entrenched” in the Jimma basalt Fm rocks, slope = 1.14 m/km
- Chainage 200-350 km: “deep incision” in ancient alluvium, slope = 0.50 m/km
- Chainage 350-660 km: “meanders” in recent alluvium, slope = 0.10 m/km
- Chainage 660-750 km: “river delta”, slope = 0.17 m/km

The routing effect of the river is smaller in the first “entrenched“ reach, where the Omo River flows into narrow valleys with quite steep bed slopes, and substantially increases moving downstream, where flatter slopes are found, becoming extremely relevant in the “meanders” section.

The following graphs illustrate the propagation of the hydraulic discharge “wave” downstream of Gibe III up to the Lake Turkana.

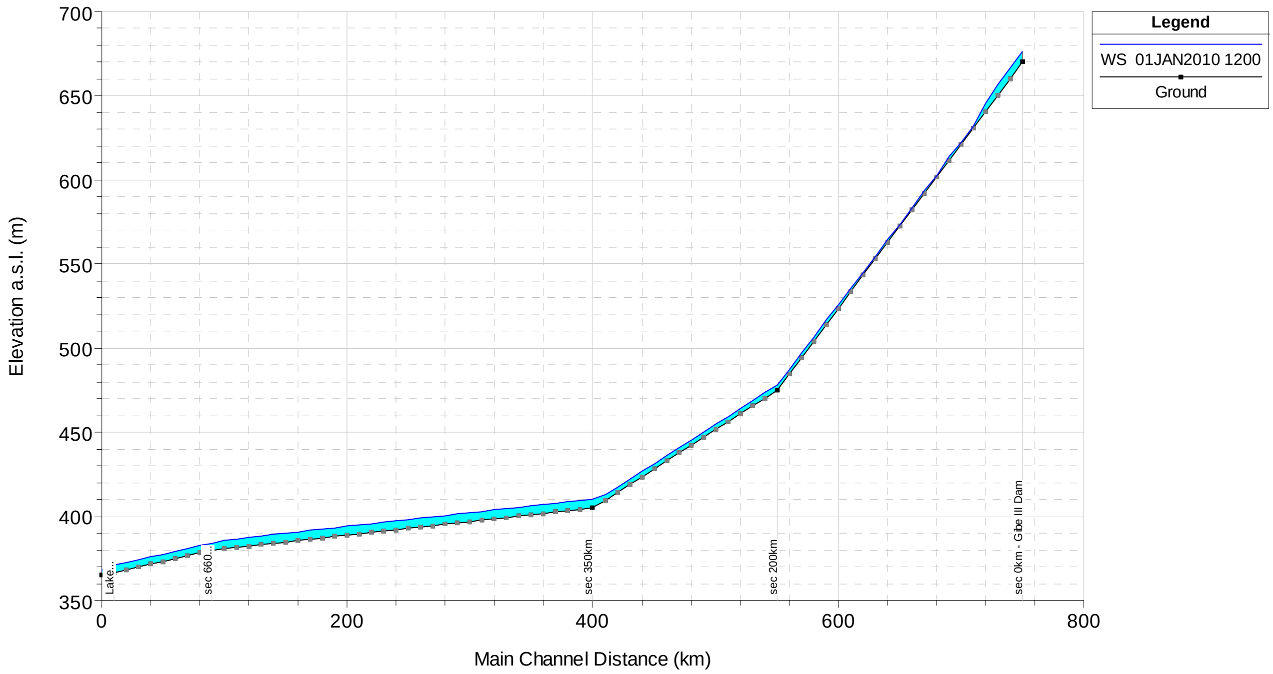


Figure 4.8: Propagation of the turbined discharges along the Omo River stretch: day 1

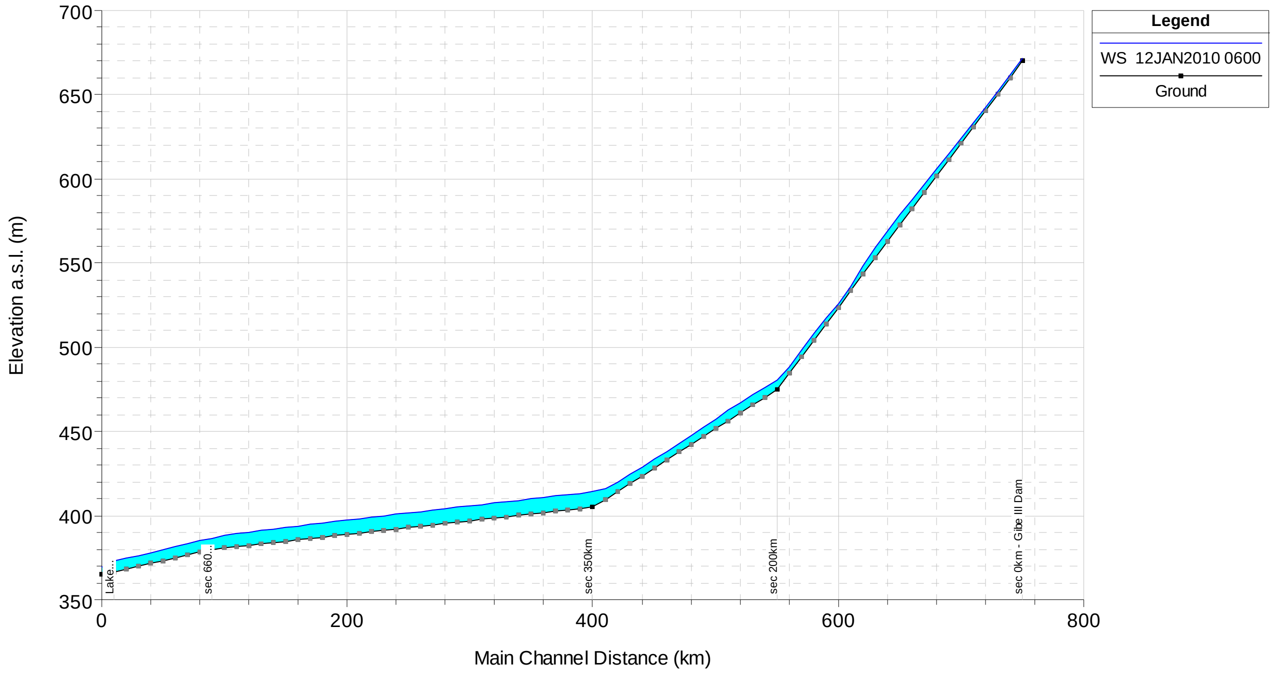


Figure 4.9: Propagation of the turbined discharges along the Omo River stretch: day 12

The figure above shows that discharges from Gibe III reach Lake Turkana in about 10 days.

The graphs below illustrate the daily fluctuations of the discharges and water levels at three sections: Gibe III site, 200 kms and 400 kms downstream of the dam.

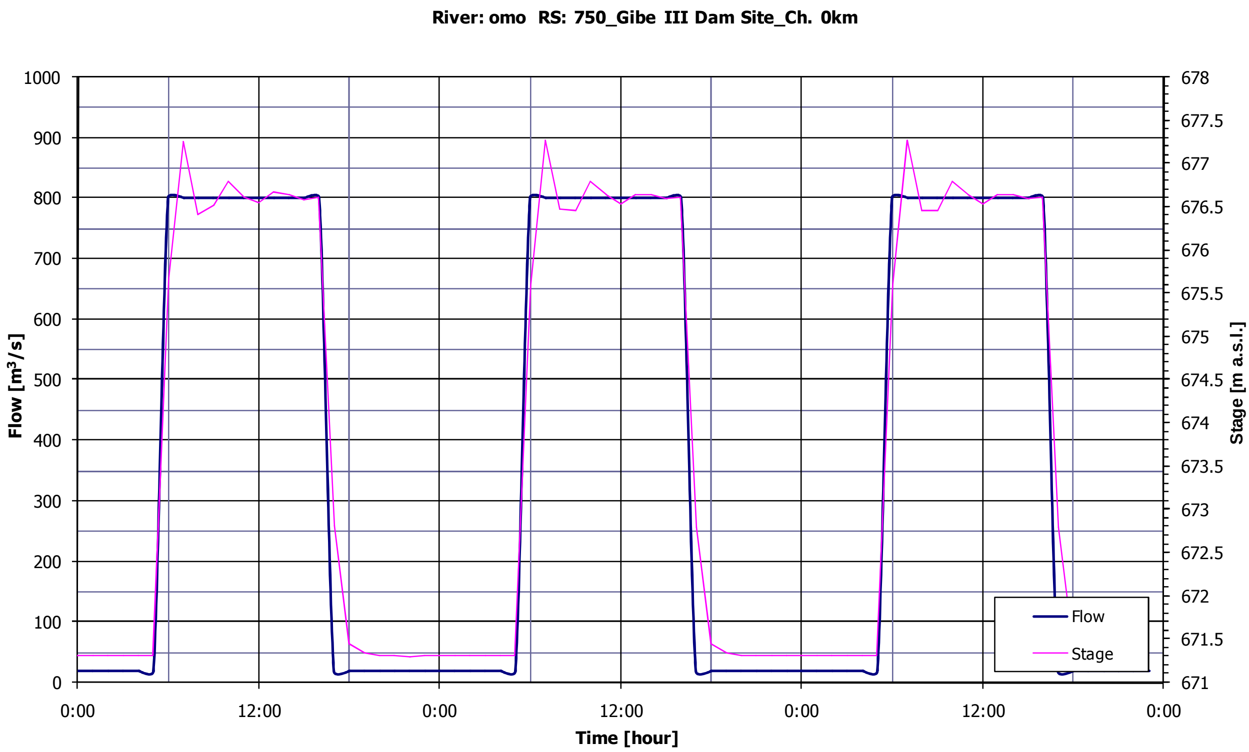


Figure 4.10: Daily fluctuation of the flows and water levels: chainage 0 km (from Gibe III)

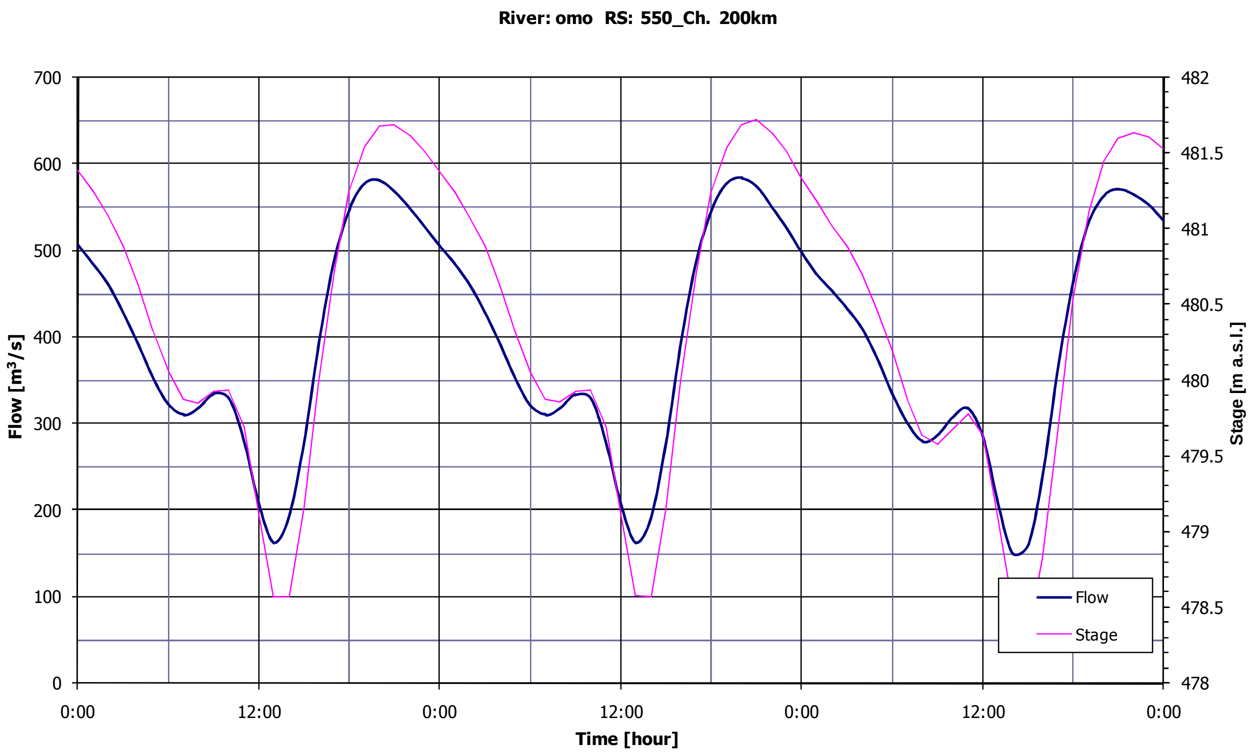


Figure 4.11: Daily fluctuation of the flows and water levels: chainage +200 (from Gibe III)

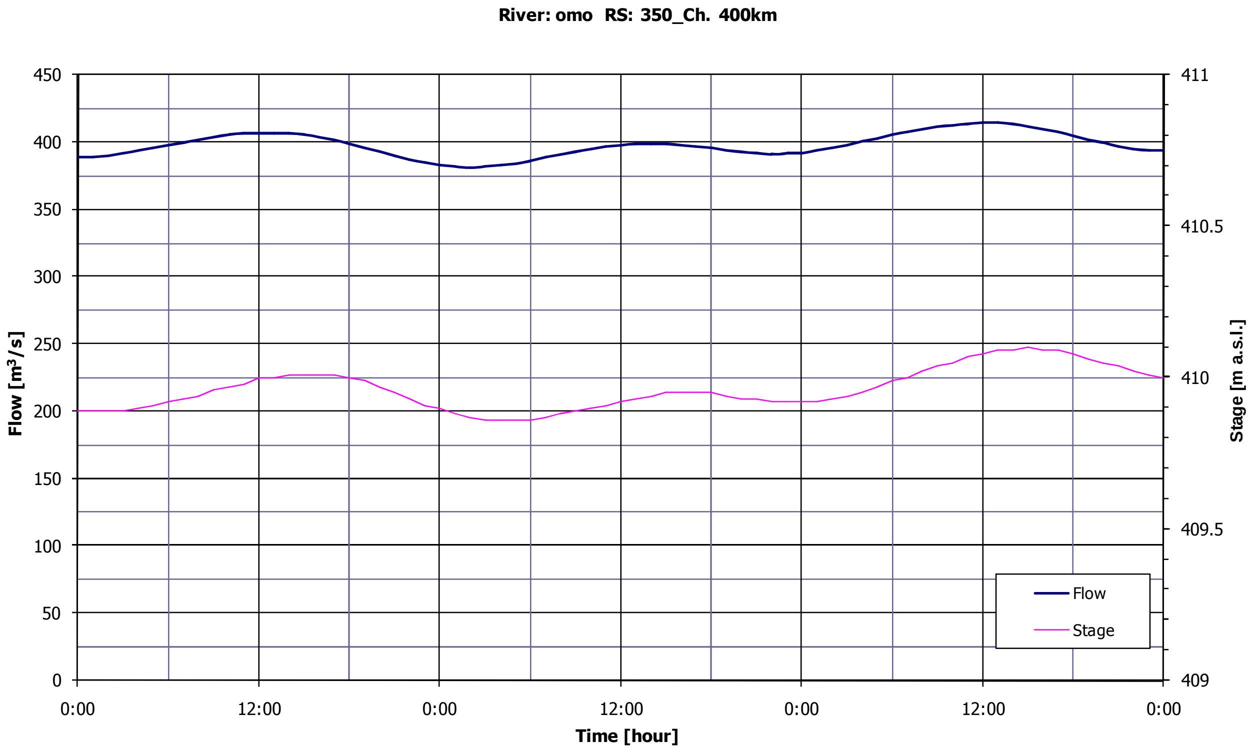


Figure 4.12: Daily fluctuation of the flows and water levels: chainage +400 (from Gibe III)

The Project Engineers' analysis clearly indicates that the relevant daily alternation of the flows is limited to the first section downstream of the dam where the river flows into narrow valleys.

Having reached chainage +200 kms the daily variation of the water levels is still significant in the range of about 2m.

Moving downstream to the second geomorphologic section the routing effect becomes particularly relevant overriding the daily variation of the flows.

At chainage + 400 kms daily variations in the water levels are negligible being in the range of 10cms, much smaller than the uncontrolled variations of the flows illustrated in chapter 2.1.4.2 (in the range of about 0.5 m).

The negative impacts of this daily alternation, particularly for the 50-100 kms downstream of the dam, especially on aquatic and riverine habitats, riverbank erosion etc, would be substantially reduced if the operational rules will envisage a production of a fraction of the energy during the evening and night hours.

The design of the plant allows, in case this more "continuous" energy production will not be possible, a minimum ecological flow of about 25 m^3/sec by means of an outlet expressly foreseen for the purpose.

Water abstraction from the Omo River will probably increase in these low-flow years, due to both:

The regulated flow of the river encouraging further development of public and private permanent intake facilities for dry-season irrigated farming, and

The flooding of the identified fluvial forest, agriculture recession and grazing grassland, through special releases from the dam.

Since present requirements combined as above with potential for future development of dry-season cropping remain negligible when compared with annual runoff, the Lake Turkana system will however benefit from a largely positive balance.

The Omo River in fact provides over 80% of the lake water resources. By retaining the unproductive runoff surplus of the extreme high-flow years in the reservoir, and releasing it in the extreme low-flow years, the dam will secure an overall increased inflow to the Lake with positive implications as discussed.

Nevertheless, likely increase in water abstraction from the Omo River may produce an adverse impact at local level in terms of water management and public health. Farmers, including agro-pastoralists who may be encouraged to introduce irrigated fodder production, have little or no experience with on-farm water management.

Little capacity and skill also exists in the local Government offices in this respect. Inadequate water management skill and drainage provisions, especially in the dry season, may result in huge water resource losses and deterioration, besides aggravating endemic water-borne diseases, and hence needs to be addressed through adequate measures of sensitisation, training, extension and capacity building at Wereda and Kebele level.

Special accompanying measures need to be put in place to mitigate these potential impacts, possibly through Technical Assistance inputs extended to the whole transition period during which water users would acquire the necessary command of the implied techniques and technologies.

The form of assistance envisaged is both direct through establishing/strengthening associations and/or co-operatives acceptable in the socio-economic context, as well as indirect in terms of training of trainees and extension staff, and capacity building in the Wereda and Kebele Offices.

4.2.1.2 Sediment transport and water quality

The northern part of the Gibe III catchment area has several tributaries, with the most relevant ones from the NE (Walga and the Wabe rivers) draining largely cultivated land where erosion processes are significant.

The figure enclosed in the following page illustrates the erosion potential mapping in the river basin.

The construction of the dam causes a reduction in the Omo River total solid transport downstream of the reservoir.

The coarse fraction of the solid transport (i.e. gravel and sand), carried from the upstream catchment, will be trapped into the reservoir.

However in the lower Omo river the sediment yield is substantially made (more than about 70 %) of extremely fine particles (colloids, clay, fine silt), which will remain in suspension during the annual operation of the reservoir.

The specific sediment yield at Gibe III site is in the range 250 -500 t/km2/year (8 to 17 Mtons / year).

A thorough monitoring program has been started, whose first results are illustrated in the appendix.

The measured Total Suspended Solid transport (TSS) varies (Gibe III site) in the range 130 to 500 mg/l, being lower in the dry season and higher at the beginning of wet season.

The data gathered confirm the measurements obtained during the previous studies carried out in the river basin (Omo River Basin Master Plan, Gibe I, Gojeb and Halele-Werabesa reservoir sedimentation studies).

Samples have been taken also upstream and downstream of the existing Gibe I reservoir.

This measurements have been carried out since the Gibe I reservoir well reflects the future physical conditions of the Gibe III reservoir.

The measured TSS values are substantially unvaried upstream and downstream of the Gibe I reservoir as illustrated in the figure below.

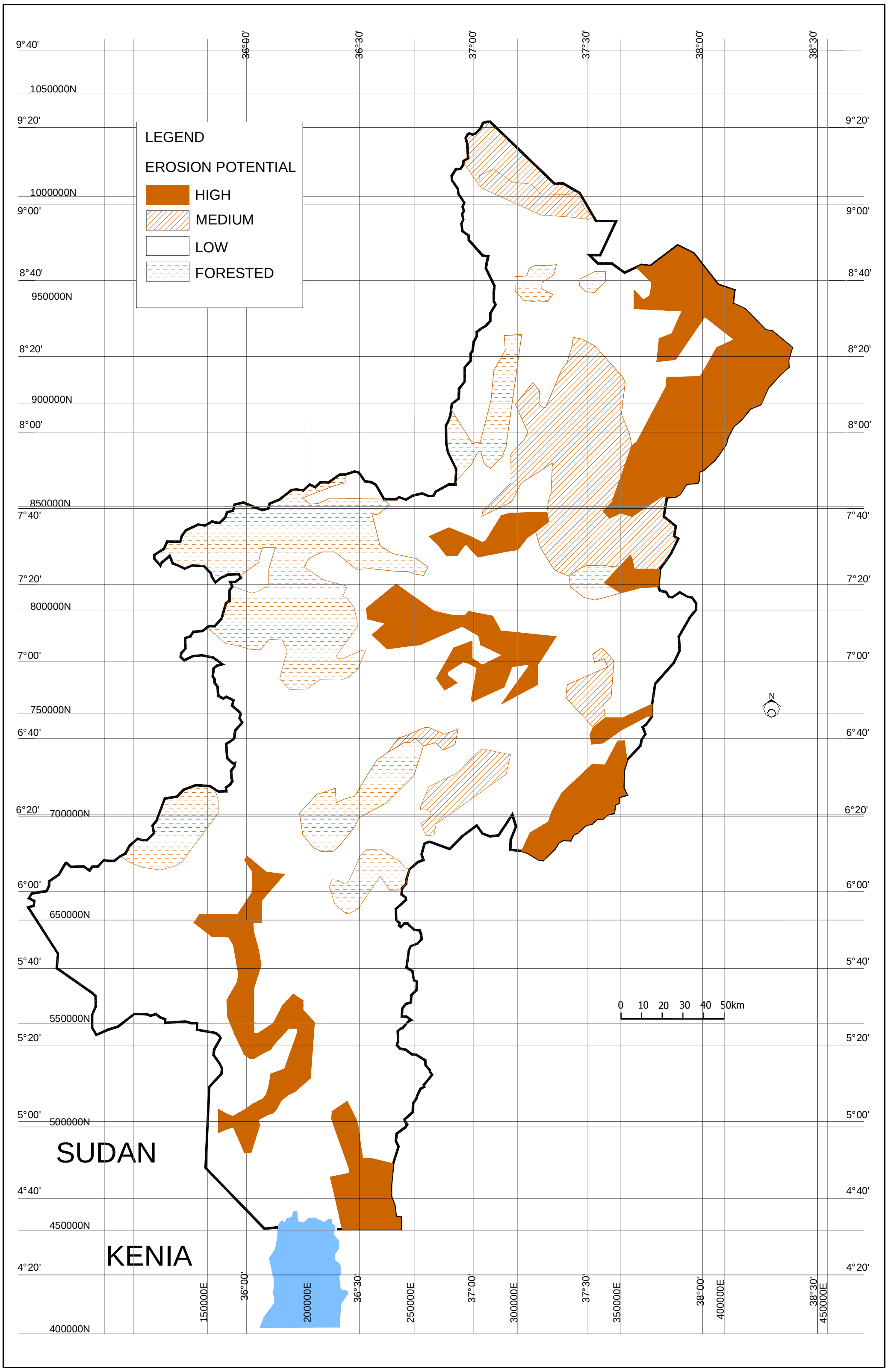


Figure 4.13: Omo Erosion Potential Map

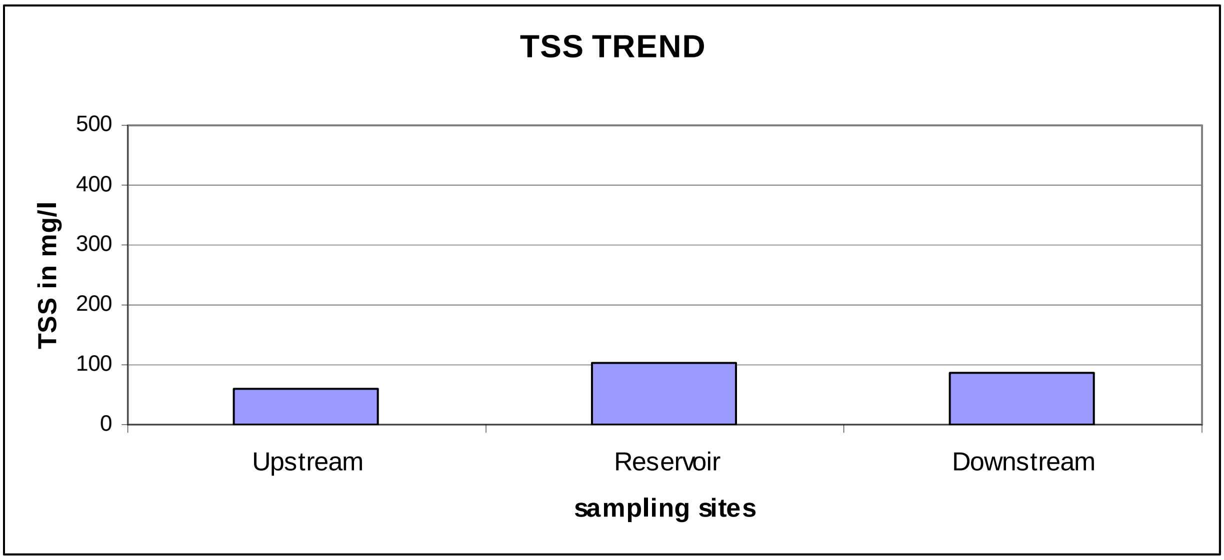


Figure 4.14: Suspended Solid Transport upstream and downstream Gibe I (March 2008)

The analysis has also been extended to relevant parameters for the quality of the waters.

Phosphorus, nitrogen, BOD (Biological Oxygen Demand) and COD (Chemical Oxygen Demand) have been measured upstream and downstream of the existing reservoir and at Gibe III site.

The following graphs indicate that measured BOD and COD values, while possibly reduced by the Gibe reservoir, do not substantially vary along the Omo River.

The phosphorus content upstream and downstream the Gibe I reservoir is substantially unvaried and is by far lower than 20 mg/l which could be roughly considered a limit to consider the lake as "eutrophic".

The nitrogen ˉwhile probably relevantly increasing within the Gibe I reservoir, also remains unvaried along the Omo River. The lake is probably "nitrogen-limited" considering this common indicator of the tropic status.

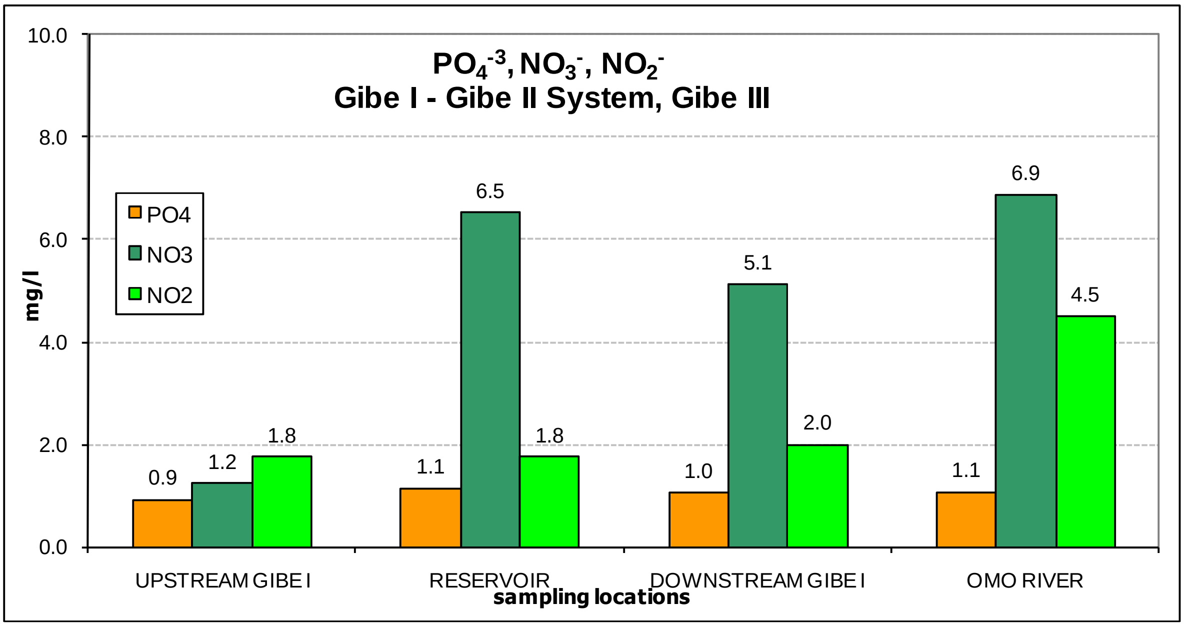


Figure 4.15: Nutrients upstream and downstream Gibe I and at Gibe III (March 2008)

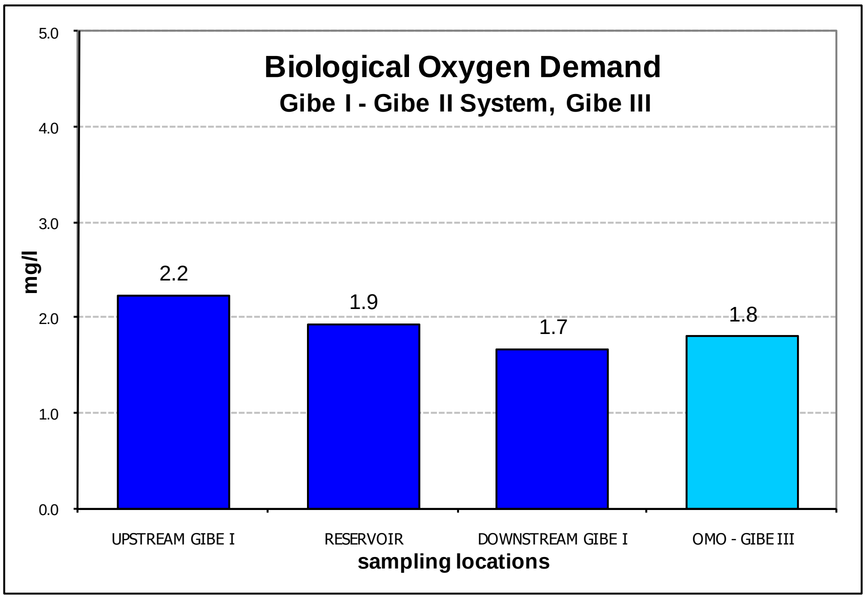


Figure 4.16: Biological oxygen demand upstream and downstream Gibe I and at Gibe III (March 2008)

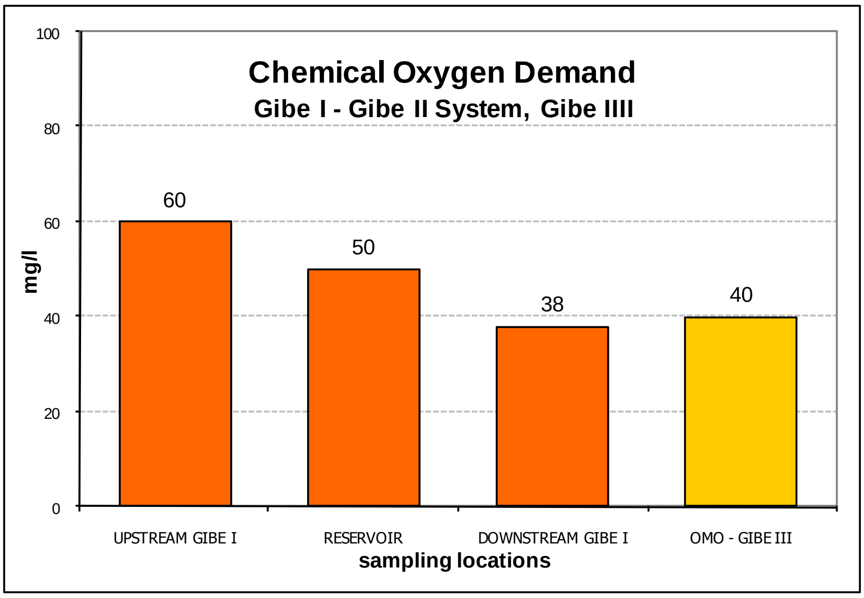


Figure 4.17: Chemical oxygen demand upstream and downstream Gibe I and at Gibe III (March 2008)

Therefore, based on these first analyses and on the results of the previous studies in the river basin, it can be assumed that:

The average total solid transport in the Omo river is composed of a relevant fine fraction (colloids, clay, silt) totalling about 80 % and of a smaller coarser fraction (sand, gravel);

The existing Gibe I reservoir operation, which well reflects the conditions of the envisaged Gibe III reservoir, indicates that:

- Average suspended solid transport (colloids, clay, silt) is not substantially reduced by the reservoir trapping effect which regulate discharges during the year;

- The coarser fraction (sand, gravel) deposits into the reservoir;
- The most relevant mean water quality parameters (phosphorus, nitrogen, COB, BOD, etc) will probably not be greatly varied by the reservoir operation.
- This is assumed also for Gibe III because of the relevant live capacity / flooded surface ratio and for the limited vegetation in the reservoir; and
- Oligotrophic conditions (i.e. quite clear lake with low biological productivity) are likely to develop in most of the reservoir.

While the water quality and the mean sediment content will not greatly change because of the reservoir operation, the trapping of the coarser sediments, coupled with the effect of restored hydrological conditions of the Lake Turkana system on the longitudinal slope of the Lower Omo River, may cause erosion at places previously characterised by sedimentation activity.

These local phenomena can be negative for the riparian environment and will need hence to be detected through regular monitoring of the suspected critical locations, and where necessary prevented by means of carefully designed river training works.

4.2.2 Impacts on biological environment

4.2.2.1 Terrestrial flora

Reduction in water level fluctuations, if not balanced by artificially-induced limited floods, as planned, may negatively influence some stretches of riverine forests, specifically those narrow formations located in the upper portion of the basin (north of Mursi Bodi area) in a strip along the river, which at present, due to presence of steep river banks, get moisture only during months of increased water presence (July to September) and on occurrence of floods.

In such locations, if not adequately provided with water the highest portions of riverine formations may not receive enough moisture for sufficiently long to guarantee their permanence in their present state, with possible consequent evolution into locally prevailing evergreen / deciduous bushland ecosystems.

However, damage to lower basin extensive riverine formations for example within river meanders of the Kara area, consisting of considerable tracts of mainly flatland, would very marginally occur (if at all) compared with the upper part of the basin.

The reason would be that, generally speaking, lower river banks and presence of additional water from southern Omo tributaries will still guarantee enough moisture to substantial stretches of forest.

Eventually, towards the delta (south of Omorate), effects on local riverine forests will be of still less significance if any, due to the very limited elevation of such formations upon the river water table, the depth of which may even increase due to regularisation of river flow.

Terrestrial inland ecosystem would otherwise not be negatively affected by Gibe III establishment, provided planned artificial floods are regularly released as envisaged, thus not causing displacement of seasonally migrating livestock herds and nomadic pastoralists.

4.2.2.2 Fish stock and Fishery resources

Dam construction across rivers modifies the upstream and downstream aquatic environments. Thus, in the absence of mitigation actions as planned (controlled flooding and adequate environmental flow) the downstream fishery would potentially be negatively affected with risks of reducing the fish yield and even extinction of some species that strictly require floodplains for breeding, should a sufficient degree of artificial flooding not be guaranteed.

It is also known that dams may as well modify the thermal and chemical characteristics of river water.

Depending on from which part of the reservoir the water is released the downstream river would get warm oxygenated water with high transparency or cool, anoxic, sediment loaded (nutrient-rich), turbid water.

The surface release lets water with high temperature but fewer nutrients, while the bottom release water lets cool and anoxic water rich in nutrient load.

Large fish kills in downstream rivers have been reported in several dams due to the cool anoxic water released only from the hypolimnion of the reservoir.

It has also been found that the low water temperature causes a reduction in the native fish species downstream due to spawning failure and decreased recruitment (Craig, J.F., 1999). Hence, all necessary precautions as designed should be made to avoid or minimize the problems in releasing water from the reservoir.

Therefore adequate mitigation and dam design measures as planned (provision of middle outlet structures within the main Gibe dam to guarantee adequate turbidity of artificial floods) shall be applied to make up for the above potentially negative features.

It is known that many fish species in the lower reaches of the Omo River undergo longitudinal and lateral migration along the river channel and into the flood plains to spawn and to feed.

These include the Cyprinids, Barbus bynni, Labeo horie, the Mormyrids, Mormyrus sp.; Hyperopisus bebe, the Characins, Alestes dentex and Hydrocynus forskahlii, also Citharinus citharus, Distichodus niloticus, the Schilbids Schiilbe uranoscopus, S. mystes ...etc. These could be potentially affected if controlled flooding of floodplains does not take place on the planned scale.

All the studied fish species are known to spawn in different parts of the water system including in the open lake, the river delta, the downstream river channel and river banks or floodplains during flooding and do not reach the dam.

Hence any potential negative impact on the abundance or diversity of the fish species may be caused should excessive changes in the controlled water release and flow regime in the river materialise.

Seasonal floods and flushing of the river need to occur in order to induce breeding activities, spawning migration, and ensure filling of floodplains and depressions such as Dipa Lake, and assure productivity of the river and yield from the delta and Lake Turkana by guaranteeing allochthonous nutrients inputs from the land.

Reports on the fish fauna of Lake Turkana indicate that some of the major species like *Aleses baremose, A. dentex, Citharinus citharus, Distichodus niloticus*, and *Barbus bynni* migrate from the lake to spawn only in the River Omo (Hopson, 1982).

A combination of factors like the dilution of lake water salinity, reduction in lake water conductivity and increased turbidity due to the large influx of freshwater flood (seasonal pulse) from the river, is said to initiate breeding activities and migration of fish to the river from the lake under normal situations.

Also, those species spawning in the shallow vegetated areas of the lake like *Clarias gariepinus, Oreochromis niloticus*, migrate to the inundated lake shore areas as water level rises.

The reduction in strength or loss of the seasonal flood pulse, from the Omo River, could reduce the rate (or number) of migratory and other spawning fish that would, subsequently, result in decreased recruitment of fish stocks both in the floodplains and in Lake Turkana.

It is known that biodiversity and productivity of fish communities is reduced as the extent of land/water ecotones declines, resulting in a reduction in terrestrial food supply and spawning and rearing habitats (Craig - www/dams.org).

Excluding the periods of artificial flows, however, it is likely that the water released could be somehow more transparent, less productive and could therefore favour, to a certain extent, the growth of rooted macrophytes that in turn affects the inhabiting fish species composition.

4.2.2.3 Fluvial and lacustrine biodiversity

Reduction in river water turbidity and sediment load for a substantial part of the year, by allowing light to penetrate deeper and photosynthesis to take place will possibly increase, as said under the previous chapter, algal presence and biomass while changing algal composition and oxygen levels, thus resulting in changes of fish species frequency, density and distribution (decreasing fish diversity).

Excessive regularisation of river floods due to the presence of a dam, if not mitigated by the planned occurrence of limited artificial floods may cause a reduction of the in-flow of nutrient-rich sediments and debris which represent crucial food sources for invertebrates, negatively affecting carnivorous and detritivorous fish species and the entire food chain in the delta area and perhaps as far as the northern shores of lake Turkana.

The above conditions may also increase risks of water eutrophication and induce invasive species (water hyacinth) predominance. In this respect, a few clumps of floating water jacinth were detected by the mission in the lower portion of Omo delta area.

4.2.3 Impacts on socio-economic environment

4.2.3.1 Agriculture

*Impacts on rainfed agriculture***:** Construction of the Gibe-3 dam will not have a direct effect on rainfed cropping, which is mainly confined to the higher lands.

It might possibly lead to an increase in rainfed cropping, in an effort to compensate for loss of recession crop area, which in turn might result in overuse of the limited amount of arable land available and more susceptibility to soil erosion.

Controlled flooding after dam construction, to allow the continuation of flood recession cropping will obviate this potential impact.

Impacts on flood recession agriculture: The ethnic groups, Dasenech, Karo, Hamer, Mursi, Murle, Mugugi and Nyangatom, all rely on flood recession and river delta crops as well as livestock for their subsistence. The potential loss of flood recession crop area, as well as grazing, would reduce their food supply and could possibly lead to conflicts over grazing areas.

It is estimated that some 20,000 families are engaged in flood recession and cropping in the delta, on 12,000ha or so, meaning that 100,000 people could be affected.

The estimated annual crop production this represents is around 5,000 tonnes which may be some indication of the extra amount of food aid which might be required if there was no controlled flooding after dam construction, to allow the continuation of flood recession cropping.

Impacts on irrigated agriculture: There will be no adverse impact on irrigated agriculture from reduced flooding, only benefits because of the regulated flow in the river, which will ensure adequate water levels at all times of the year.

The planned release from the reservoir intended to artificially induce flooding of both the river banks and floodplains, as well as the provisions for a minimum environmental flow, will mitigate and full compensate all adverse effects.

In the event that the annual release is not being implemented as scheduled, some possible adverse impact may occur as described below:

- Possible unexpected changes of traditional lifestyle and production system,
- Possible (short period) households minor income reduction,
- Possible increasing human and animal pressure on the riverine area, and
- Conflict between population – local authorities and between livestock keepers and farmers.

The following map represents the major possibly affected target group, namely households depending exclusively on food recession agriculture.

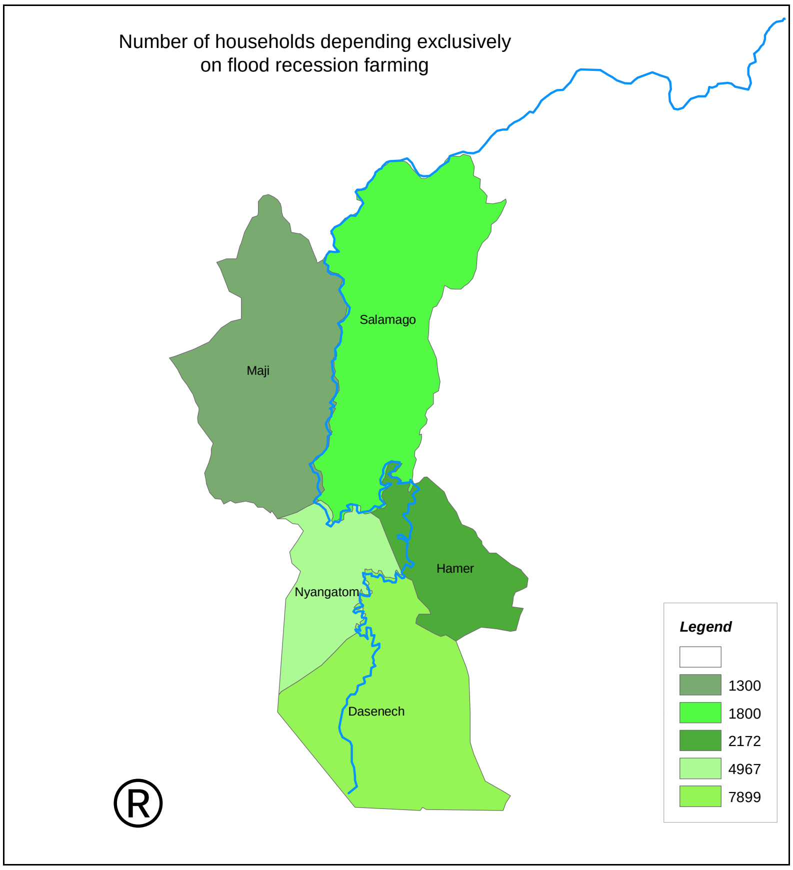


Figure 4.18: Number of households depending exclusively on flood recession / delta farming

A key factor in the development of the agricultural potential of the Omo Basin is the establishment of a fully effective extension service based on the Peasants Training Centre (PTC), adequately funded with a well-trained and motivated staff having full mobility.

The extension service should be more oriented towards solving farmers' problems through training courses at the Kebele level. It is recommended that much greater emphasis be given to on-farm trials. They require far less time for monitoring and direct supervision than formal research design trials and are therefore less costly to implement.

They provide great insight on how farmers adopt and adapt to new farming technologies. The direct involvement of farmers also facilitates feedback on the usefulness and practicality of the new technology. Furthermore, they provide for a closer interaction between the research/extension worker and the farmers themselves.

This helps to promote the development of confidence and mutual respect between both parties, leading to a deeper understanding of each other's problems. To implement this proposed strategy, a well-trained and motivated team will be needed in the Wereda office.

They will provide in-service training, specific technical advice, monitoring of trials and demonstrations.

There is potential within the Basin to develop small-scale irrigation schemes. These facilities can radically improve the income and ultimately the standard of living of those in the community with access to them. The ability to grow crops throughout the year or if only supplementary irrigation, to minimize the possibility of crop failure, can totally improve farmer's economy.

4.2.3.2 Livestock

Livestock keeping dynamics, and consequently the pastoral semi-nomadic way of life of a great proportion of Lower Omo inhabitants would be damaged, by a cessation of or by an abrupt decrease in extent of floods.

Such an occurrence needs to be avoided, as it has indeed been planned by releasing controlled floods equalling to about the current average mean annual floods.

In fact, although no major negative impacts will be expected within Salamago Wereda, as the river there is utilised mainly for cattle watering, higher degrees of damage would be inflicted within flooded and low lying seasonal marshes areas of Nyangatom and Hamer utilised for grazing. Most of the negative effects would be felt within the extensive floodplains of Dasenech, which are presently grazed for a substantial number of months also by neighbouring ethnic groups.

4.2.3.3 Tribal people

Competition over cultivable land along the Omo River and competition over the crop produced were primary sources of conflict in the past particularly between the Nyangatom and the Kara, the Nyangatom and the Mursi, the Kara and the Kewegu, and the Kara and Murile.

Informants stated that today, cultivable land along the river is privately owned, with the right to cultivate such land obtained either by inheritance or by permission of the traditional owners of the land.

With the coming into being of the Gibe III Hydroelectric Scheme, if the regulation of the water flow will not be counter-balanced by artificial floods as planned, disruption of the system of annual natural floods may result in conflicts of interest in controlling the land itself where limited inundation takes place, while increased human pressure would be put on rainfed areas thus potentially sparking new sources of conflict.

This type of competition could lead to clashes amongst competing parties. Furthermore, the absence of flooding of past magnitude may favour differently located floodplains and low lying areas on both riverbanks, traditionally utilised for fishing and grazing by different communities which again may instigate multiple conflicts on the utilisation of dwindling natural resources, with related intensification of raiding parties and killings.

Should the above occurrence materialise for lack of planned mitigation in terms of controlled flood release, then conflict resolution actions will need to be planned and put in place, including strengthening of the on-going peace making initiatives, as well as other physical compensation measures.

The planned main mitigation measures have included a set of physical and management measures meant to achieve a suitable river flow regulation whose strict implementation will permit local traditional socio-economic activities to perform on the same levels (as those on average prevailing at present). These measures also guarantee recession agriculture and safeguard the communities from disastrous floods and years of crop failures (one in three years) due to insufficient water levels and uncertain duration of occurrence.

Provided all the recommended measures are implemented, there are no ethnic minorities or tribal people whose traditional lifestyles could become compromised through the development of the Gibe III hydroelectric project. Therefore, no indigenous development plan will be required.

4.2.3.4 Social services, facilities and infrastructure

The special release from the reservoir intended to artificially induce flooding of both the river banks and floodplains, as well as the provisions for a minimum environmental flow, will mitigate and full compensate all adverse effects.

Hence, concerning the South Omo downstream area’s Social Services, facilities and infrastructure, no considerable direct adverse impacts are indicated.

4.2.3.5 Public health and safety

As discussed in the relevant section, significant increase in water abstraction from the Omo River may occur, especially in low-flow years, due to possible development of public and private permanent intake facilities for dry-season irrigated farming, and flooding of the identified fluvial forest, agriculture recession and grazing grassland, through special releases from the dam. This may produce adverse impacts at local level in terms of public health.

Farmers, including agro-pastoralists who may be encouraged to introduce irrigated fodder production, have little or no experience with on-farm water management. There is also little capacity and skill on this in the local Government offices.

Inadequate water management including effective drainage, especially in the dry season, may result in aggravating endemic water-borne diseases, and hence needs to be addressed through adequate measures of sensitisation, training, extension and capacity building at Wereda and Kebele level.

Special accompanying measures need therefore to be put in place, through an adequate Technical Assistance input extended to the whole transition period during which the water users will acquire the necessary command of the implied techniques and technologies.

The form of assistance envisaged is both direct through establishing/strengthening associations and/or co-operatives acceptable to the socio-economic context, and indirect in terms of training of trainees and extension staff, as well as capacity building in the Wereda and Kebele Offices.

5 PUBLIC CONSULTATION

5.1 Objective of Public Consultations

The FDRE Constitution contains a number of articles relevant to the issue of environment in public development projects, and the general environment as a whole. As stated in the National Policy, the principal objective of public consultation is highlighted under article 92 of Chapter 10, which could be described:

"People have the right to full consultation and to the expression of their views in the planning and implementation of environmental policies and projects that affect them directly".

Public consultation therefore plays a key role in bringing peoples' participation into project planning, and implementation that affects the people directly.

The public consultation process is designed in order to:

Inform, and contribute to identifying potential impacts of the project, either negative or positive or both, and prioritise the remedial measures for the identified impacts;

Include the attitudes of the community and officials who will be affected by the project so that their views and proposals are mainstreamed to formulate mitigation and benefit enhancement measures; and

Increase public awareness and understanding of the project, and ensure its acceptance.

5.2 Public Consultation Methodology

The effects of water resources development projects in a particular area are limited not only to their immediate environment, but will well extend to downstream areas. This necessitates identifying all potential project effects, and possible remedial measures.

Public consultation therefore is compelled to include all relevant downstream territories. This study has been focused to the maximum possible extent on consultative meetings held with people living in the down stream area of the project.

During consultation, the community's knowledge, perception and attitude towards project benefits and potential impacts were duly taken into consideration. The following methodologies were applied during public consultation.

Review of Secondary Data: Before launching consultative meetings, insight was gained from various studies related to the subject under study. Points of discussions were gathered aimed at facilitating discussion for securing the intended out put. Several related issues were designed for discussions to include:

Gaining first-hand knowledge of major benefits that the Omo River provides to communities.

Identifying major potential impacts of Gibe-III hydro power project;

Identifying potential benefit enhancement and mitigation measures.

Field Trip: Consecutive field trips were taken to the reservoir and the downstream areas in order to collect views and attitudes of the concerned stakeholders situated within and around the vicinity of the project areas. Field trips to the reservoir and the downstream places were conducted in the years 2006 and 2007.

Group Discussion: Great care was taken to select groups, with samples taken from different villages, Weredas and zones, in such a way to incorporate and represent attitudes and views of the entire communities and officials. The samples focused on economically active people, by selecting individuals randomly from the project-affected population, with different age categories ranging between the minimum of 20 and the maximum of 72 years of age.

Meetings: Several meetings and discussions were held with members of the community, and their leaders, drawn from various sector's offices at regional level. They were briefed about benefits and potential adverse impacts of the project, along with the legal frameworks for implementing proper mitigation measures.

Consultative meetings were facilitated by the team of experts comprising economists, sociologists and environmentalists having relevant work experience and qualifications in the field.

The consultative meetings were conducted in Amharic since the language is well understood by the majority of the population. However, in case of need, local languages were also used to conduct discussion with the community and individuals making use of local interpreters.

Illustrative pictures: In order to illustrate the presentation more clearly, consultative meetings were supported by photographs taken in different areas of the project as required.

5.3 Consultation Process Results

The study covers only one zone from the Southern Nations Nationalities and Peoples (SNNP), with the identification of 4 Weredas. These include Hamer, Dasenech, Nyangatom, and Salamago, as project affected Weredas in the downstream area of the project.

There are many Kebeles or peasant associations that are organized under the Weredas, while Kebeles in turn consist of several settlements (villages). On the basis of the environmental scoping and findings of preliminary reviews, the following stakeholders were identified for consultation:

- Government officials at Federal, Regional, Zonal, Wereda and Kebele level; and
- Local communities and people directly affected by the project;

In the project area, three offices at different levels are directly accountable to the concerned activities at the Kebele, Wereda, and Zonal level with the Kebele being the lowest administrative unit. Such offices are responsible for overseeing progress attained in implementation of Government activities taking place within their administrative jurisdictions.

Beside, households and their family members living in various villages of the Kebele do have also an interest in project implementation since they are directly or indirectly affected by project activities, and were therefore duly interviewed.

In the consultation process, a total of 165 participants drawn from different administrative levels were consulted. Of these, 4 were contacted from Zonal offices, 49 from Wereda officials, and 116 from representatives of the different ethnic groups at Kebele and Village level.

Sample minutes of meetings and unofficial translations of the transcription of the consultations held are presented in Appendix 8. Persons contacted and institutions visited are listed in Appendix 9.

5.3.1 Zonal Administration Meetings Résumé

Zonal Authorities made clear that people living in the different Weredas, with particular reference to communities residing along riverbanks, are largely dependent upon the Omo River for their livelihood. The contributions of the project to the development of the country in terms of local development opportunities and energy potentials were discussed.

The Zonal Administration was informed that the Gibe III development will not cause an all-out reduction in the river flow, but rather, a regularisation of flow was to be expected.

Possible negative impacts on local populations stemming from an expected reduction of floods were highlighted, pointing out that mitigation actions in terms of artificial floods, as well as agricultural, livestock and fishery support activities were advocated.

Picture 19: Discussion with South Omo Zone ARDB Official Photo

Picture 20: Discussion with Dasenech Wereda Officials

5.3.2 Views of Wereda Administrations

The study team conducted discussions with Wereda officials and experts of the Weredas situated downstream of the project.

The discussion was made to assess the perception and attitude towards the proposed project, through which awareness will be created about the project in order to gain support for their (Weredas) future participation in project implementation and monitoring during the different phases of the project (construction and operation).

The views of the Wereda officials concentrated on the identification of the different impacts as well as proposing mitigation measures for the potentially negative effects that could have been expected.

Assurances were sought that the project implementation will not negatively affect socio-economic and natural environment of the different Wereda with particular reference to the livelihood of the ethnic groups residing on the floodplain of the river.

A substantial decline in the production of crop and fishing was feared in the absence of proper mitigation actions.

Future expansion of small scale irrigation which can be operated by diesel or wind pump as well as creating artificial lake to sustain and improve fish production, and releasing of artificial floods, were seen as suitable mitigation measures.

5.3.3 Views of the Community

The Community stressed the importance of the Omo River for agricultural, livestock and fishery activities both for home consumption as well as for commercial and economic aspects.

It was felt that the project could accelerate the expansion of small-scale irrigation developments in the area thus permanently improving the standard of living of the local community.

Potential negative consequences were also aired by community, expressing concern and fears that the Omo River will undergo a reduction of flow, thus affecting crop production (reduction of recession cultivation) and fishing.

Lack of grazing lands would also result in serious shortage of livestock feed and other related problems. Shortage of livestock feed is particularly felt as a critical problem for all the communities residing along the riverbank due to the fact that many of the people are pastoralists owning large number of livestock.

Mitigation measures including controlled flooding to guarantee overflowing of the river and thus continuation of recession agriculture and presence of riverine green grazing lands, as well as development of small-scale irrigation schemes were discussed to offset potentially negative project impacts.

Picture 21: Consultation with Dasenech Communities near Omorate

Picture 22 Consultation with Hamer Wereda, Karadus Communities

Picture 23: Consultation with Selamago Wereda, Mursi Communities

Picture 24: Consultation with Dasenech Communities near Lake Turkana

5.3.4 Consultations with Wildlife Department (WCD) and Protected Areas Personnel

The Wildlife Conservation Department of the Ministry of Agriculture and Rural Development (MoARD/WCD) is the responsible governmental body entrusted to oversee the Omo and Mago National Parks.

The ministry's was requested to provide comments on the potential impacts of the project upon the Parks and the surrounding areas.

WCD was informed that the downstream area may get almost constant flow of water throughout the year, apart from controlled releases of water (artificial floods) at the annual peak flood period.

WCD confirmed that there are people in the National Parks involved in farming activities, though at a very limited scale using traditional farming systems.

According to the office, there are no identified wildlife species that are entirely dependent on grass grown on floodplain. The livestock and wild animals have abundant grazing lands outside the river courses and therefore they will not be seriously affected by the project.

There will also not appear to be any significant effect upon the aquatic life in the National Park areas.

Currently, "community tourism" is initiated and this is taking tourists from Lake Turkana upstream on the Omo River through small hand operated as well as motorized boats. By this package a tourist will visit the National Parks as well as the indigenous people of the area. Therefore, excessively fluctuating water levels (as at present) would be a hindrance to operations.

5.3.5 Views of NGOs and other Organisations

Currently Farm Africa, Ethiopian Pastoralist Area Research and Development Association (EPARDA), Catholic Church and Refuge Trust are amongst associations actively involved in the socio- economic development activities taking place to in the Lower Omo area.

These organizations finance the implementation of various socio-economic development activities, which encompass sectors such as health, education, water supply, livestock development, conflict resolution, food security, natural resources and agriculture.

The implementation of the Gibe III project will have potential impacts upon the communities residing along the lower Omo River. A plan for development interventions was regarded as being desirable in order to offset or minimize impacts on various economic activities in the fields of crop production, fish and livestock grazing.

Development of small-scale irrigation, forage development, demonstration plots for crop and forage, and fish marketing were mentioned amongst some of the activities that will mitigate these possible impacts.

6 ENVIRONMENTAL MITIGATION & BENEFIT ENHANCEMENT MEASURES

6.1 Physical Environment

6.1.1 River flow regulation for environmental protection

An environmental flow, meaning a necessary flow of water to keep the Gibe downstream aquatic and riverine environment healthy, is a prerequisite that has been kept into consideration within the present study. Such a planned water release is required in order to offset the impact of dam-induced changed flows on downstream aquatic ecosystems; as far as possible, planned environmental flow releases are designed to mimic the natural occurring flow regime.

The Australian Government Environmental Flow Guidelines (1999) defines environmental flows as follows: "… The stream flow necessary to sustain habitats (including channel morphology and substrate), encourage spawning and the migration of fauna species enable the processes upon which succession and biodiversity depend, and maintain the desired nutrient structure within lakes, streams, wetlands and riparian areas. Environmental flows may comprise elements from the full range of flow conditions which describe long term average flows, variability of flows including low flows and irregular flooding events."

River flow regulation therefore is to be based on ecological and socio-economical parameters (Environmental Flow) to keep into due consideration water needs of downstream environments, including the groundwater system, to enable them to continue performing ecological functions to the maximum possible extent, also in order for the downstream ecosystems to support existing industries and communities that rely on water resources.

River flow regulation, consequently, represents a first, important step of a downstream integrated water resources management holistically meant to take care of aquatic ecosystems while providing for long-term economic viability.

Under the above concept, the Omo River flow resulting from the Gibe-3 Hydropower development, consisting of normal (operational) environmental base flow, as well as high-flow-season controlled flooding combined together, would effectively contribute towards as many as possible the following ecological tasks:

Table 6.1: Ecological functions performed by different river flow levels (Postel and Richter 2003)

Flow component	Ecological roles
Low (base) flows	Normal level • Provide adequate habitat space for aquatic organisms • Maintain suitable water temperatures, dissolved oxygen, and water chemistry • Maintain water table levels in floodplain, soil moisture for plants • Provide drinking water for terrestrial animals • Keep fish and amphibian eggs suspended • Enable fish to move to feeding and spawning areas • Support hyporheic organisms (living in saturated sediments) Drought level • Enable recruitment of certain floodplain plants • Purge invasive, introduced species from aquatic and riparian communities • Concentrate prey into limited areas to benefit predators
High pulse flows	• Shape physical character of river channel including pools, riffles • Determine size of stream bed substrates (sand, gravel, cobble) • Prevent riparian vegetation from encroaching into channel • Restore normal water quality conditions after prolonged low flows, flushing away waste products and pollutants • Aerate eggs in spawning gravels, prevent siltation • Maintain suitable salinity conditions in estuaries
Floods	• Provide migration and spawning cues for fish • Trigger new phase in life cycle (e.g., insects) • Enable fish to spawn on floodplain, provide nursery area for juvenile fish • Provide new feeding opportunities for fish, waterfowl • Recharge floodplain water table • Maintain diversity in floodplain forest types through prolonged inundation (i.e. different plant species have different tolerances) • Control distribution and abundance of plants on floodplain • Deposit nutrients on floodplain • Maintain balance of species in aquatic and riparian communities • Create sites for recruitment of colonizing plants • Shape physical habitats of floodplain • Deposit gravel and cobbles in spawning areas • Flush organic materials (food) and woody debris (habitat structures) into channel • Purge invasive, introduced species from aquatic and riparian communities • Disburse seeds and fruits of riparian plants • Drive lateral movement of river channel, forming new habitats (secondary channels, oxbow lakes) • Provide plant seedlings with prolonged access to soil moisture

Prescribed river flow regulation, inclusive of base flow and controlled flooding have already been considered as successful options in many similar developments, including Tiga / Challawa Gorge Dam in Nigeria, Manantali Dam in Senegal, Kafue Gorge in Zambia, Cahora Bassa in Mozambique, Tucurui Hydropower Complex in Brasil, Berg River Dam in South Africa andc. (see bibliography in Appendix 1).

The following main mitigation measures have been included since the conceiving of the dam project. Such measures are intended for immediately offsetting possible adverse environmental impacts while allowing for beneficial aspects to take place, and development potential accruing from implementing physical and capacity-building measures of environmental mitigation to be expressed in full.

The proposed measures will provide the basis for successive adjusting and fine-tuning to the most environmentally sound regulation of the river flow, and will concern both the design of the works and the envisaged dam operational modalities.

6.1.2 Minimum Environmental Flow

In the unlikely event that the plant will not be in operation, a minimum ecological flow of about 25 m^3/sec will be released by means of the outlet device in the powerhouse expressly designed for the purpose.

The discharge of 25 m^3/sec basically corresponds to the lowest monthly average dry season flows encountered during the period 1964-2001 (March 1973). This is considered more appropriate to guarantee the health status of downstream lacustrine environments beyond and above the existing minimum environmental discharge requirement of 15 m^3/sec as prescribed by the Employer's Requirements of the EPC Contract.

This proposed discharge, identified on the basis of existing hydrological records, is to be adopted as a provisional measure to ensure sustainability of riverine ecosystems pending more appropriate parameters as resulting from the foreseen activities on geomorphological and ecological river response (cfr. chapter 6) as elaborated within an appropriate hydraulic model (cfr. Para. 6.1.3), with gradual passage between purely hydrological to environmental techniques being considered as standard international practice.

The intake of the ecological outlet is placed at about mid height of the reservoir (el 800 m a.s.l.).

This is being planned since water stratification is usually evident in deep reservoirs and such an arrangement will minimize the release of low O_2 and low temperature water from the hypolimnion of the reservoir, thus avoiding damages to the downstream riverine environment as observed in several hydropower plants.

The ecological flow will therefore maintain the minimum natural dry season conditions immediately downstream of the dam.

The relevant discharges coming from the perennial affluents in the residual basin will substantially contribute restoring the natural conditions further downstream.

Where the plant will be continuously inoperative for some days the large middle outlets will allow the full release of required downstream environmental flows.

The required discharges vary during the year and the operating rules will be also established according to the duration of the required stop in energy production.

6.1.3 Wet -season controlled flooding

A controlled flood release is foreseen from the reservoir during the month of September (or end of August) to coincide with the peak flows from the residual basin.

This release is intended to reproduce the natural average floods conditions while limiting the downstream flooding to a required extent, in duration and in areas.

The envisaged characteristics of these floods (duration, outflows) are:

Period:	September	(or last two weeks of August)
Flows:	1000 – 1200 m^3/sec	(at Gibe III)
About :	1600 m^3/sec	(at Lake Turkana)
Duration:	10 days	(peak flow)

The period corresponds to the last weeks of the natural hydrological floods and slightly varies each year depending on the contributions from the residual basin Gibe III - Turkana.

The discharges are in the range of the monthly average natural flows at Turkana during the month of September (Q=1500 m^3/sec) as illustrated in the figure 6.1 below.

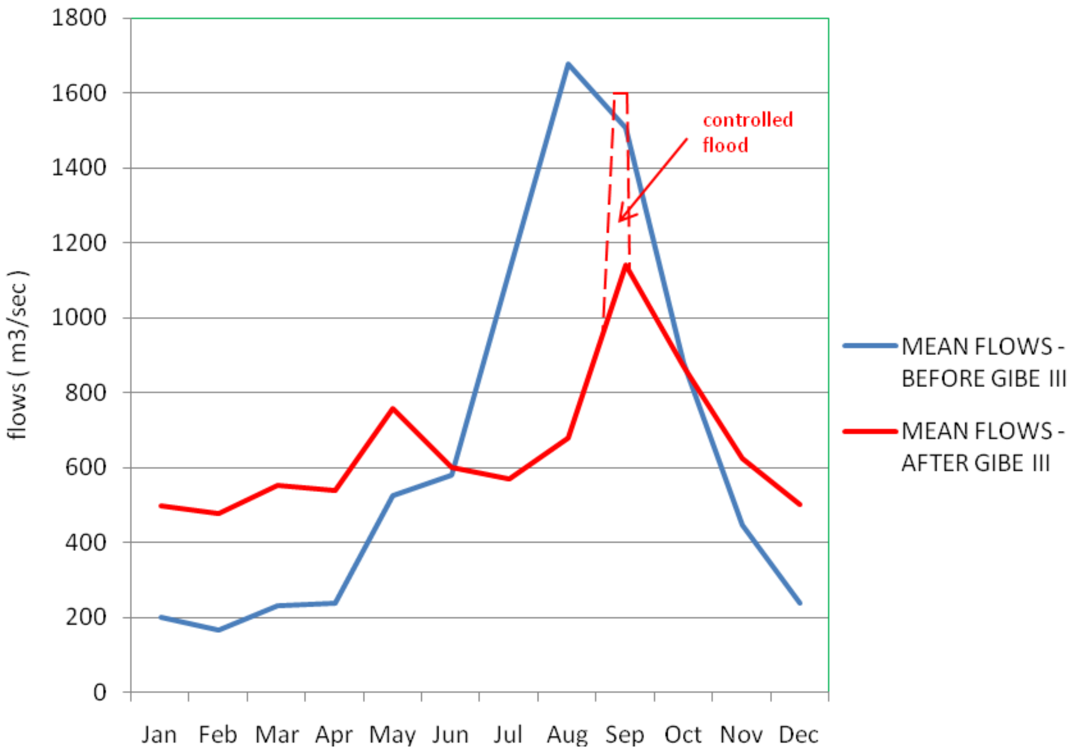


Figure 6.1: Monthly flows at Lake Turkana: average 1964-2001

This volumes discharged from Gibe III will allow, nearby the lake Turkana, recreating a flood reasonably similar to a natural yearly "average" flood with a duration of about 7-10 days.

The discharges will be quite gradually increased during a few days (2-4 days).

During the first years of operation of the plant the optimum characteristics of the controlled floods will be assessed by means of a testing program with the monitoring of the downstream effects.

The remarkable flexibility of the plant, with two middle-outlet structures reaching a total maximum design discharge of about 2,150 m^3/s, allows the optimisation of the discharges during the plant operation.

During the wet years (i.e. inflows substantially higher than 14 Mm^3) or whenever the inflows will be substantially higher than the outflows required for the energy production the duration of this flood can be substantially increased and the discharge might be also slightly increased up to a maximum which will be assessed during the testing program.

This controlled flood will guarantee the timely discharge of the required flows for the agriculture, livestock and fishery sectors, as well as the entire natural ecosystem.

This flooding is needed to maintain the overall productive, biological activities and related biodiversity values by allowing annual regulated submersion of adequate portions of the Lower Omo basin.

Periodically (i.e. every 5 years) floods of longer duration may also be envisaged to partially replicate naturally occurring events and ensure satisfactory fulfilment of a number of biological functions.

The planned annual release therefore reproduces the "average year" natural flooding conditions in accordance to what suggested by the IUCN "timing and duration - of artificial floods - should resemble natural floods as closely as possible" (IUCN, Senegal River; see bibliography).

Graphed curve of biomass volumes has shown that 10 days can be considered as a viable minimum for the above process to have significant value.

The release will be envisaged during the period of high flows from basin downstream of the dam.

The suspended sediment transport of fine inorganic and organic debris, assumed as not substantially varied by the reservoir operation, will be in sufficient quantities to continue feeding freshwater micro and macro invertebrates (zooplankton) and detritivorous / carnivorous fish while eventually depositing in downstream environments to the benefit of the entire trophic chain.

This suspended solid transport will also continue to benefit downstream cultivation, pasture and lowland forests and the seasonally flooded ecosystems.

This periodic water release from the reservoir is scheduled to produce the flood pulse required to stimulate the downstream natural environments. This period, basing on the rainfall and flood record, is between August and September.

This flood is therefore synchronized with the biological rhythm of aquatic species that require a fresh water flood pulse. A lack of synchronization would hinder migrations for spawning or for feeding. Leading to a serious impact on flood-plain spawners (Merron *et al.* 1993).

The release will contribute to limit the risks of eutrophication as well (excessive proliferation of aquatic macrophytes).

It can be therefore concluded that these controlled floods allow the reproduction of a natural "average" flood.

However, fine-tuning in terms of intensity and duration of flood release will be assessed during operation following the regular monitoring of downstream socio-economical and biological effects.

The hydraulic model will allow the assessment of the most appropriate hydrological regime.

Acreman et al. (2001) recalls the series of critical steps required to successfully implement a controlled flooding program:

- Establishing the links between floods and the floodplain ecosystem;
- Defining objectives for flood releases;
- Determining the structural feasibility of flood releases;
- Defining flood release options;
- Assessing impacts of different flood release options;
- Determining the financial feasibility of flood releases;
- Developing stakeholder participation and institutional support for releases;
- Selecting the best available flooding option;
- Establishing a monitoring program to evaluate flood releases;
- Generating pilot flood releases; and
- Providing feedback for the adaptive management of future flood releases.

These elements, as identified in the course of the present study will be further elaborated in the future and are essentially aimed at confirming the feasibility and effectiveness of the recommended measures. By using the information collected through monitoring the project data base will be expanded and these measures will also be improved when necessary to ensure that the anticipated impacts are avoided or mitigated. Therefore, should the environmental monitoring determine operation poses an environmental concern; the operation will be modified accordingly.

6.1.4 Assessment of controlled flooding

6.1.4.1 Background

A site visit flying the Omo River Valley from the Gibe III Dam site up to the Turkana Lake was carried out in July 2008 in order to inspect the river floodplain areas right after the first high flow period of the year (see Figure 6.2).

Scope of the survey was to confirm or eventually refine the assessment of the "controlled flood" to be released from the Gibe III outlet devices.

Information derived from the photo interpretation are used to decide weather the first flood of the year was as large as needed to inundate all the bank areas where recession-farming takes place. Results of the analysis are quantified combining the visual information with all the available Gibe III hydrologic data (historical data and new hydrometrical readings) (see section 6.1.4.3).

The helicopter flight was accomplished on the 20th of July about 9 days after the occurrence of the first peak of the 2008 wet season recorded at Gibe III dam site (1,460 m^3/s).

Aerial photos reveal that the lower Omo valley was plentifully flooded since:

- the Omo Delta was widely inundated and cultivated land and land used for grazing were totally submerged. Woodland areas were also partially submerged; and
- the Meandering Part of the river stretching some 350 km, where recession agriculture is developed, was intensely interested by the ingression - recession process due to the first flood of the year. Bank and overbank areas including permanent recession-farming areas near the riverbed had been submerged little earlier than the survey.

Hydrological data show that the investigated flood event is well represented by the flow sequence recorded at Gibe III since:

- no flood preceded the hydrological event under study;
- the July 2008 runoff is perfectly aligned with the value obtained by averaging 38 year record of data; and
- the average contribution of the intermediate catchment between dam site and Lake Turkana is only 19% on July and consequently the hydrologic behaviour of the residual catchment very weakly affects the flood formation process.

The available hydrologic data reveals that the peak of the flood under examination was about 1,650m^3/s at Lake Turkana. It is also estimated that during the site visit of the 20th of July a flow ranging from 900 to 1,100 m^3/s was travelling through the Lower Omo River Valley depending on the river chainage.

It is derived from this preliminary analysis that a flood having a peak of about 1,600 m^3/s at Lake Turkana but more persistent (say 7 days peak) would produce the complete inundation with adequate submergence time of the riverside bank areas yearly utilized for post-flood-recession agriculture.

This important finding is very supporting having confirmed the initial estimate of the annual average controlled flood performed within the Gibe III Environmental and Social Impact Assessment (ESIA) and illustrated in next chart.

As already discussed in this Additional Study of the ESIA, the best time for releasing the controlled flood for cultivation purpose corresponds to beginning of September. Being the average runoff contribution of the residual basin during September (about 40% of Gibe III), this implies an average flow to be discharged from Gibe III outlet devices ranging from 1,000 to 1,200 m^3/s within 10 days from the beginning of the month.

Considering that the annual runoff at Gibe III of 440 m^3/s is daily released through the turbines, the additional discharge of less than 800 m^3/s (1,200 - 440 m^3/s) shall be released downstream of the Gibe III Plant. Such flow can be discharged adopting one of the two middle outlets envisaged.

In light of the above the Gibe III middle outlet design looks adequately precautionary and able to ensure the proper management of the water resource for recession-agriculture and grazing purpose after the completion of the dam and filling of the reservoir.

6.1.4.2 Results of Arial photo survey

The helicopter flight was carried out on the 20th of July by a team of river geomorphologyst and an expert in Omo Valley agriculture. Take off was at 9.00 AM from Gibe III dam site and after having flown directly to the Turkana Lake at the border between Ethiopia and Kenya the team headed for Gibe III accomplishing the photo survey with a GPS camera travelling northwards. Pictures were all taken flying about 150 m above the ground.

GPS photos of the site visit are provided with UTM coordinates. The most representative pictures are presented in this section.

For a better understanding a general map and the river-bed profile from Gibe III to Turkana including the geomorphological classification are shown in Figure 6.2 and Figure 3.2 respectively.

As known, further upstream the river is entrenched and the banks are high enough and no flooded areas had been detected. Picture 25 (taken approximately 320 km d/s of the dam site) represents the end of this entrenched and fairly straight stretch of the river (where riparian banks are still steep). Downstream from this point the river enters the Lower Omo Valley (see Figure 6.2) and begins to meander while recession farming starts appearing on river banks.

Picture 25: (Photo N. 05) - UTM: East 158,494; North 611,796. (320 Km d/s of Gibe III). 20 July 2008

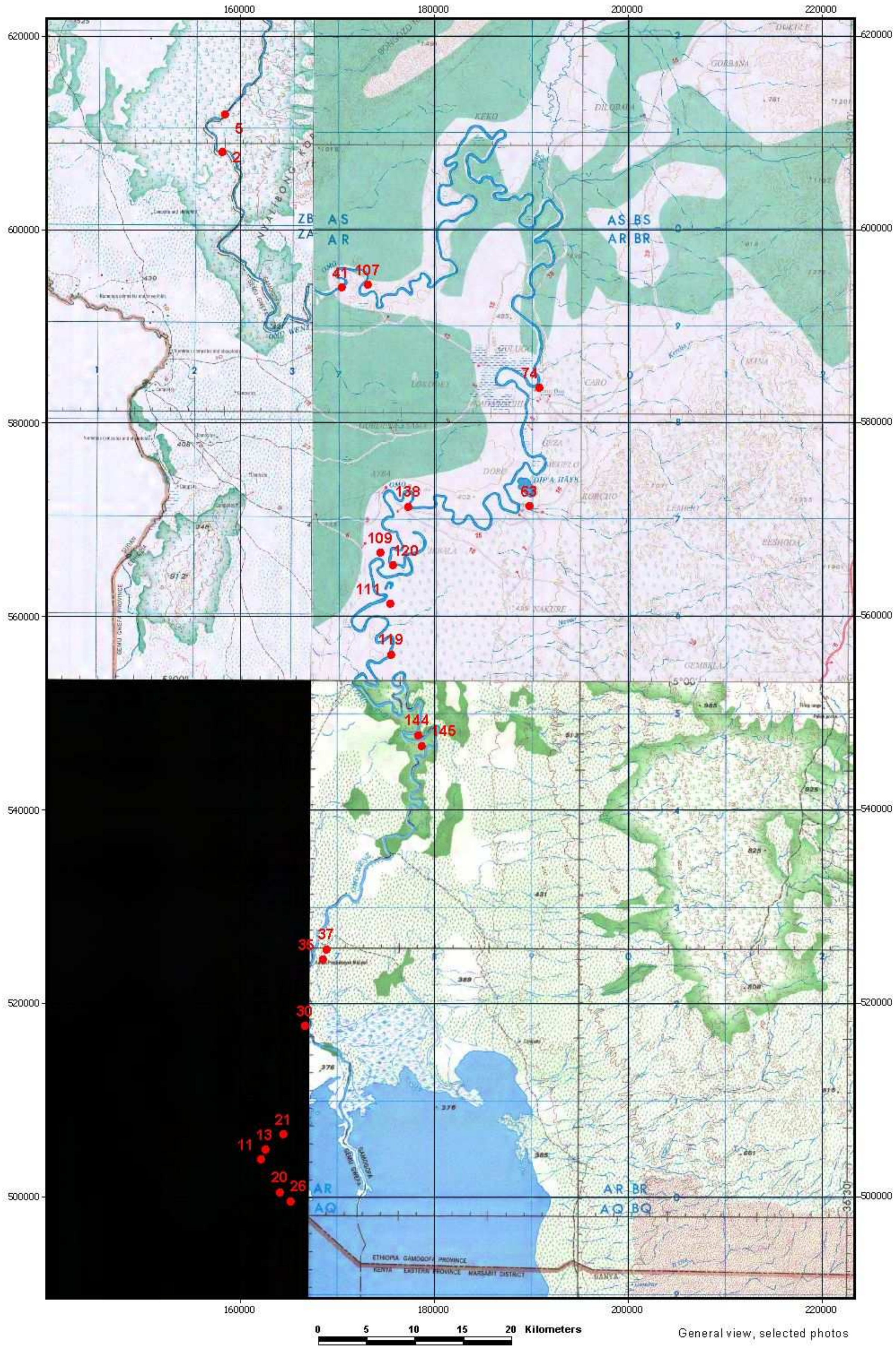


Figure 6.2: Lower Omo River Valley. Map of the Arial Photo Survey dated 20th of July 2008

The Omo delta had been plentifully inundated some days before the survey by the river flows and the Lake Turkana watertable raised by the heavy rainfall of the antecedent days and by the other tributaries high flows. Cultivated land and land used for grazing had been totally flooded and some woodland areas as well.

Travelling upstream up to the beginning of the meanders the floodplains had been sufficiently flooded some days before and still appeared partially inundated. In many areas the river water already subsided at the time of the survey leaving evident marks of the flood passage yet.

Most of the over-bank areas including the recession agriculture areas near the riverbed were either submerged or had been submerged little earlier. Lake Dipa was full and wide areas aside the river had been inundated.

Picture 26 shows an extended flooded area located on left side at the beginning of the Lower Omo valley. Recession agriculture areas marked on the right side had been recently inundated.

Picture 27 exhibits the area of Karadus village recently flooded. Some recession farming areas were still submerged having been flooded few days earlier.

Picture 26: (Photo N. 107) - UTM: East 173,230; North 594,153. (355 Km d/s of Gibe III). 20 July 2008

Picture 27: (Photo N. 74) - UTM: East 190,868; North 583,515. Karadus Village (450 Km d/s of Gibe III). 20 July 2008

6.1.4.3 Hydrology

Estimate of the river discharges at Gibe III during the 2008 wet season is obtained adopting the available hydrometrical readings nearby the dam site.

The water level data from the gauging station named Diver #10 (installed in previous position #1) is adopted for deriving the daily flow sequence of July 2008. The Diver#10(1) stage-discharge curve is graphed and shown in Figure 6.3.

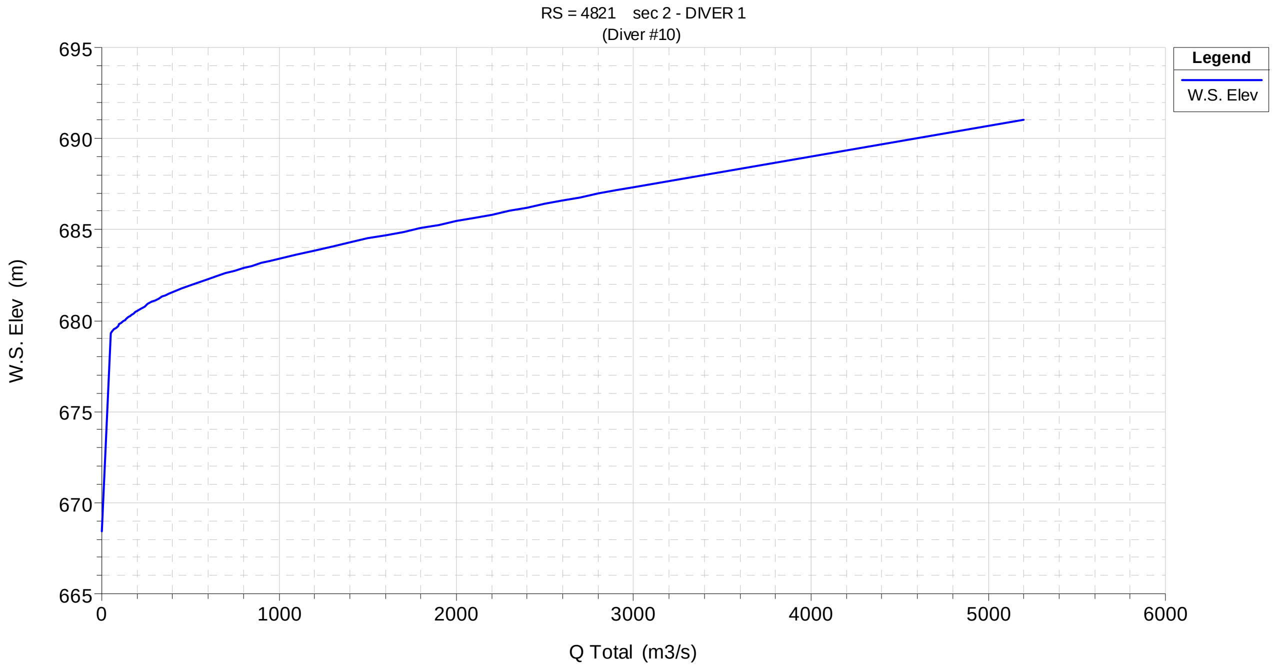


Figure 6.3: Rating Curve adopted for estimating July 2008 flows at Gibe III Dam site

Daily mean water level data of the logger installed in position #10 during July 2008 are shown in Table 6.2 while the river daily flows derived from the rating curve at the Gibe III Dam site are graphed in Figure.6.4.

Table 6.2: July 08. Daily mean water level data at Diver #10

day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
W.L.	681.9	681.7	681.9	682.0	682.4	682.6	682.8	683.5	683.7	683.5	683.7	684.5	683.7	683.3	683.3	683.3
day	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	
W.L.	682.9	683.0	683.1	683.1	683.5	683.4	683.4	683.9	684.0	684.1	685.2	683.7	684.0	684.6	684.6	

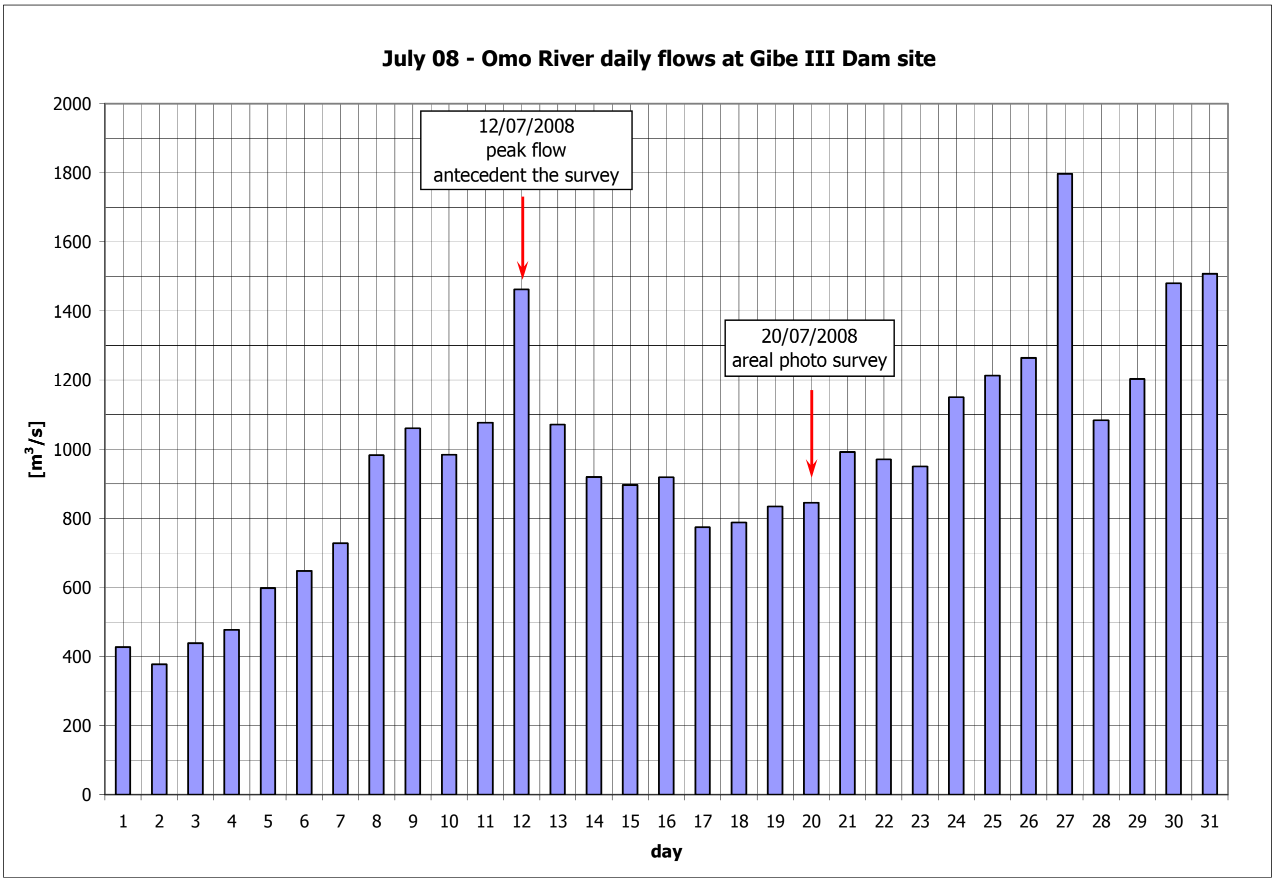


Figure 6.4: July 2008 daily flows at Gibe III Dam site

Estimated discharges of July 2008 vary in the range 400 – 1800 m^3/s. The flow distribution was bimodal with two independent peaks the first of the 12th (1460 m^3/s) and the second, the largest, of the 27th (1800 m^3/s) An average flow of 965 m^3/s was recorded while the annual average flow basing on 38 year record (1964-2001) is 942 m^3/s. Thus, July 2008 well represents average hydrologic condition at Gibe III dam site.

Monthly contribution of the catchment residual to the Lake Turkana had been estimated in section 3.1.4 of this report.

The contribution of the residual catchment is particularly relevant, if compared to the upstream basin, in the dry season. During the dry months a natural regulation of the Omo river flows at the Lake Turkana derives from the contributions of the residual basin Gibe III - Turkana (see Figure 6.5).

In July the residual contribution is particularly low having a transposition coefficient at Turkana of 1.2. In average terms, the hydrology of the intermediate catchment between Gibe III dam site and Lake Turkana very weakly influences the hydrological behaviour of the whole catchment during July.

During the wet months (especially July and August) the flood formation process can be successfully monitored through the Gibe III dam site gauging stations.

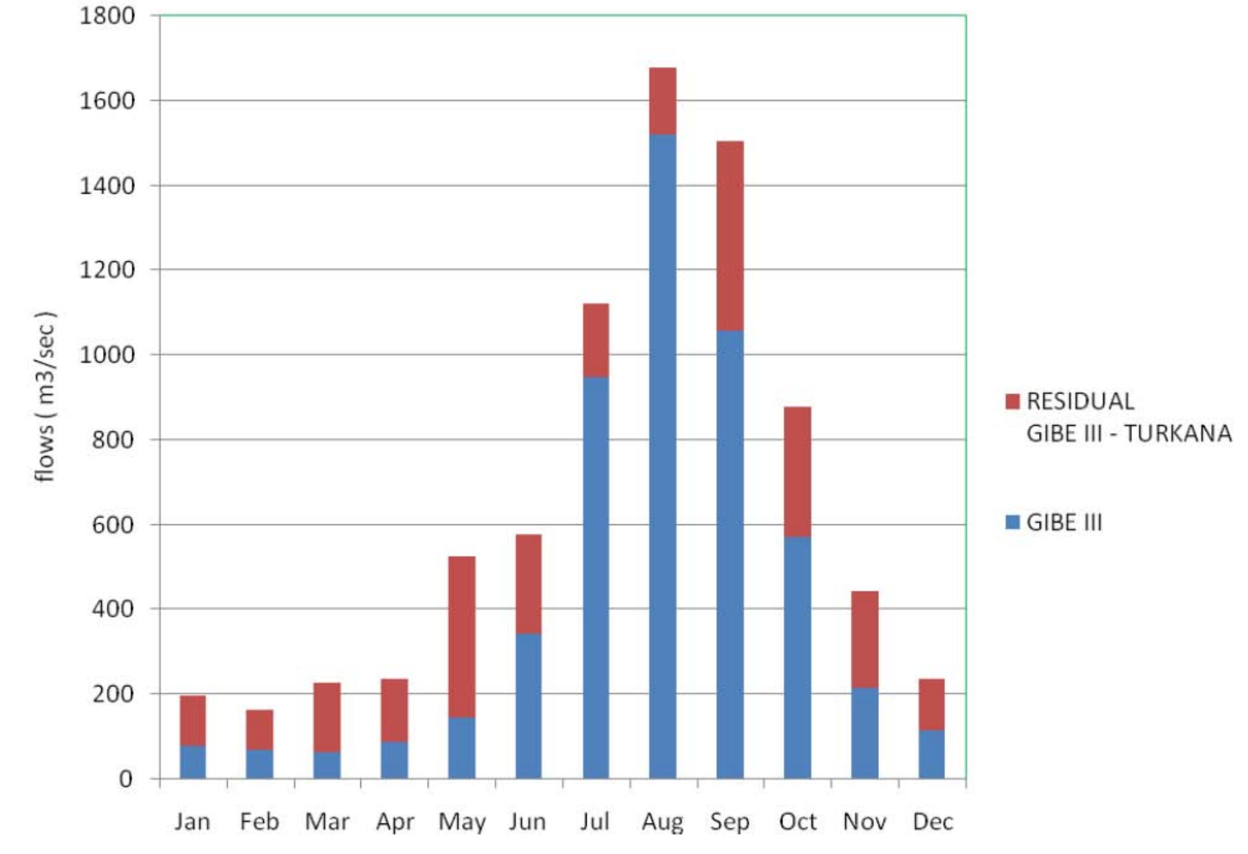


Figure 5.15 – Average monthly runoffs at Gibe III, Residual and Lake Turkana.

Figure 6.5: Average monthly runoffs at Gibe III, Residual and Lake Turkana

Source: Gibe III ESIA-Additional Study on DS Impact, 300 ENV R AG 003 A, March 08

In conclusion, it is estimated that the peak runoff of 1460 m^3/s of the 12^{th} of July recorded at Gibe III would be worth about 1650 m^3/s at the River Delta.

Due to the very long travel time (some days) between the Gibe III and Turkana, the downstream effects of the peak travelled through Gibe III on the 12^{th} are well-visible in the aerial photo survey of the 20^{th}.

6.1.5 Downstream flows during construction and first impoundment

It is also important that the river flow would not be discontinued at the initial period during the filling up of the reservoir.

This is a start of the management process that has been planned in order to avoid the damaging consequences on the aquatic biodiversity and production system.

Many dams whose river water flow was drastically reduced during the reservoir filling stage have experienced biodiversity loss and extinction of fish stocks downstream.

During the construction phase the diversion tunnels allow the full passage of the incoming flows.

A small "routing effect" for the largest floods, obtained by the cofferdam reservoir flood capacity, immediately allows a reduction in the highest peaks contributing to the protection of the downstream environment.

During the first filling of the reservoir a temporary ecological outlet is envisaged through the dam body to allow a small outflow of some 20-50 m3/sec within the first months of the rainy season.

This ecological release, together with the relevant contribution of the downstream basin, will be used until the reservoir level reaches the middle outlets sill level allowing a complete control of the discharges as necessary.

6.2 Additional Mitigation and Compensation Measures and Social Development Plans

Further desirable instruments have been considered, and may be applied to both integrate the above main measures, compensate in case planned artificial floods are partially withheld due to unforeseen circumstances, and as desirable confidence-building actions to strengthen support of local authorities and populations.

These follow-up actions are not considered to be Contractor's obligations but rather be ascribed as financial and technical responsibility of EEPCO and the Government of Ethiopia and be included as such within the existing local official developmental planning, possibly as a profit-sharing measure on returns originating from sales of electricity accruing to the Federal budget.

The project area is one of the least developed in the country with poor communication and other development related infrastructures.

With the current Gibe III hydropower project it could be expected that better development programs and more investment possibilities will be possible for the public and private sector.

6.2.1 Fish stock and Fishery resources

Approach to the fishery sector may follow both the resource and biodiversity conservation point of view while approaching the fishermen community through different options.

Fish Resources and Biodiversity Conservation: The development of habitat indices for fish assemblages in the Omo River may be necessary in order to determine the exact flow requirements (Craig - www/dams.org) and remains beyond the scope of the present work.

It should be said that the increased release of water should be long enough to initiate the breeding process and contribute to natural gonad development; in fact enough water is planned to be released to create the flood regime to enable the floodplain fish species to migrate and spawn.

The flood water should allow at least for the parent stock to spawn at the river bank or flooded area and return to the main channel; the flooding time (alone) is thus estimated to be about ten days.

This said, it is however possible that even with the suggested synchronized release of the flood water there would still be less fish production from possible reduced recruitment as decreased nutrient input form the riverine water could also lower the lake productivity and consequently fish stocks.

In this latter case, restocking water bodies with fish fry of native species by rearing in hatchery ponds is another method suggested to cope with the problem of fish biodiversity and the decrease in stock size.

This is envisaged to rehabilitate the species that seem to disappear fast (vulnerable but valuable species). However, this action is taken under very stressing conditions since such hatchery-reared fish do not always compete well in the wild. The high technology, facilities and the required skilled manpower need also to be developed in the case of Gibe III project.

Other Fisheries Supporting Actions: Other measures that may be considered focus on improving efficiency in the use of the fish stocks, as these appear to be at present largely untapped.

Such supporting activities are meant to enhance income of the fishing community and/or increase efficiency in the production system and will require inputs in terms of:

- Training and extension services to improve technical skills of fishermen as well as promotion and distribution of their products;
- Provision of more efficient fishing gear, fishing nets, hooks lines, etc;
- Motorized fishing boats and engines for the lacustrine fishery on Lake Turkana;
- Infrastructure development - fish store, processing plants, fish shops, and access to credit;
- Developing and promoting sport fishing activities/programs and tourism.

Summary of fishery support activities cost is presented in Appendix 5.

6.2.2 Agriculture

6.2.2.1 Release of controlled flooding for recession agriculture

As discussed above, a survey was carried out to confirm or eventually refine the assessment of the "controlled flood" to be released from the Gibe III outlet devices. Based on this assessment it was confirmed that the extensive grassland and permanent cultivation areas of the River delta had been flooded after the occurrence of the first peak of the 2008 wet season recorded at Gibe III dam site (1,460 m^3/s) (see picture 28 to 29).

Picture 28: (Photo N. 11) - UTM: East 162,195; North 503,573. (River Delta). 20 July 2008

Picture 29: (Photo N. 26) - UTM: East 165,512; North 499,452. (River Delta). 20 July 2008

Effects of the July high flows over an area where recession farming is particularly developed are well-illustrated in the picture 30a and especially image of picture 30b taken from satellite in the same location during crop-ripening period show the presence of several huts, access tracks and pile-dwelling granaries for storage.

Picture 31a also gives evidence of a recession area partially flooded during the hydrological event antecedent the date of the survey. Maize plants of the preceding season were still visible but had been bent by the flood. A comparison with picture 31b reveals that the percentage of the flooded area was about 50%.

Picture 30a: **(Photo N. 144) - UTM: East 178,351; North 547,308. (590 Km d/s of Gibe III). 20 July 2008**

Picture 30b: **Location of (Photo N. 144). Image from Google Earth during crop-ripening period**

Picture 31a: **(Photo N. 37) - UTM: East 168,939; North 525,462. (690 km d/s of Gibe III) 20 July 2008**

Picture 31b: **Location of (Photo N. 37). Image from Google Earth during the dry season**

The flood also covered the sandy banks of the river meander as can be noticed comparing picture 32a with the satellite image of picture 32b where the recession agriculture appears light green and the sandy islands and banks are exposed. As shown in picture 32a, a recession agriculture site is sufficiently flooded.

Picture 32a: (Photo N. 111) - UTM: East 175,467; North 561,194. (535 Km d/s of Gibe III). 20 July 2008

Picture 32b: Location of (Photo N. 111). Image from Google Earth during dry season

6.2.2.2 *Improvement in Recession Agriculture*

The peak controlled floods releases shall be adjusted during the first years of operations to be adequate in flow and timing to achieve the current natural penetration in the soils and for soil moisture to carry the crops through to maturity while maximising killing of weeds germinated by the water, thereby allowing continuation of current practices.

Farmers currently follow a form of "zero-tillage" which depends on there being virtually no weed growth at the time of planting. Pre-soaking of sorghum seed, which is a common practice to speed up crop germination, helps to give the crop an advantage over weeds as well as well as enabling crop establishment before the soil surface dries out.

Sorghum and maize are deep-rooted crops, reaching depths of 180 cm or so and flood water will take around 24 hours to penetrate to this depth in sandy soils and 48 hours in a clay loam (FAO, 1978). The following table gives infiltration rates for different soil textures:

Table 6.3: Flood Water Infiltration Rates and Associated Soil Textures

Infiltration Intensity	Final Infiltration Rate (cm per hour)	Soil Texture
High	3.0 to 8.0+	Sandy, loam, sandy clay loam
Medium High	1.5 to 3.0	Loam, silt loam
Medium Low	0.5 to 1.5	Clay loam, clay, silt clay loam
Low	0.2 to 0.5	Clay, adobe clay

Source: FAO Irrigation and Drainage Paper 1, 1978

The alluvial soils of the lower Omo valley, where most recession agriculture takes place, are highly variable. In the Omo-Gibe Master Plan Study, Final Report, Volume XIII, H4, Pages 82-83, the soils are described as follows:

"South Omo Plains: This large unit of 518,000 ha occupies the plains on both sides of the Omo River, in the extreme south of the Basin, from the Delta north to the Nyalabong Hills. The alluvial soils are deep but highly variable. Soils are often clays although lighter bands may occur within the profile; lighter soils also occur on fans emanating from the higher land to the east and west, and on levees, while depressional areas may be poorly drained. Some of the depressional soils are vertic. Other soils show a tendency to sodicity."

The obvious variability in soil texture means that it will be necessary for controlled flooding to cater for the heaviest soils, allowing for at least 48 hours of flooding.

The amount of time to be allowed for flood cover to reduce weed competition will need to be some 7-10 days. Most annual weeds will germinate within 3 - 7 days, and be killed by the flood water thereafter.

With a flood deep enough, the growth of perennial weeds and grasses should be suppressed for long enough to allow the people to plant on clean ground. According to the information received in the field, the flood usually stays for about one-two weeks before the water recedes.

Peak flooding normally occurs between August and September and the water recedes 2-3 weeks later to allow planting from September to October.

Together with the measures as foreseen under the planned river flow regulations, more support actions for both rainfed and irrigated agriculture meant to increase productivity and attain self-sufficiency in the Lower Omo may be envisaged such as:

- An assessment of needs and priorities for capacity building of the agricultural extension services;
- The provision of technical assistance, vehicles and equipment to the agricultural extension services in selected Kebeles;
- Training of extension workers;
- Assisting the extension service with strategic planning, location and design of trials, demonstration plots, nurseries etc.;
- Assisting with procurement of inputs – seeds, fertilisers, tools, water measuring and recording equipment, stationery etc.;
- Assisting with analysis of trial results, and
- Assisting with the costs of farmer training – field days, visits to demonstrations etc.

6.2.2.3 Improvements in Rainfed Agriculture

As stated earlier, the dam project will not directly affect rainfed crop production at the higher elevations where floods do not reach, but the communities that practice rainfed cropping are also dependent on post-flood recession crops.

It could therefore be argued that improving the output of rainfed cropping will be important to help compensate for any adverse effect on livelihoods, giving people more food, increased cash income and better nutrition.

The main project intervention to achieve this goal will be capacity building of the Wereda and Kebele extension services, through training, transport, equipment and technical assistance.

They will then be capable of assisting farmers to deal with the main constraints, which are facing them at present. Important activities would include:

- promoting development of agro-forestry,
- promoting the use of water conservation techniques,
- introduction of conservation farming techniques,
- introducing improved crop varieties,
- promoting crop diversification,
- carrying out on-farm crop trials and demonstrations,

- facilitating the supply of tools, seeds, fertilisers and chemicals,
- improving crop storage methods, and
- promoting the formation of farmers associations.

The proposed interventions in rainfed agriculture may comprise:

Capacity building of the government agricultural extension services: Capacity building of the government agricultural extension services at Wereda and Kebele levels will be the principal intervention in rainfed agriculture, with technical assistance, training, transport and equipment. This will aim to ensure that they are equipped to carry out the activities proposed to improve output from rainfed farming systems, some of which are discussed as follows:

Agro-forestry: Trees have deep roots that can reach moisture below the depths of crop roots and, once established can often survive the dry season and continue to grow and produce food and fodder. The deep roots bring nutrients to the surface and leguminous trees enrich the soil with nitrogen as well as producing protein rich fodder. Trees can also be used to control soil erosion as well as providing firewood and building timbers. Appropriate species might include Pigeon pea (*Cajanus cajan)*, Moringa (*Moringa oleifera)*, Tephrosia (*Tephrosia vogelii*), Leucaena (*Leucaena leucocephala)*, Sesban (*Sesbania sesban*), *Acacia faidherbia*, Neem (*Azadiratcha indica*) and *Jatropha curcas*. . Some have insecticidal properties which are useful in pest control (e.g. Neem and Tephrosia) while others produce valuable oils (e.g. Jatropha and Moringa).

Water Conservation: Rainfed farming in areas where rainfall is marginal and unreliable will benefit greatly from employing water conservation measures, such as the use of tie ridges and pot-holing in row crops, as well as earth dams and run-off harvesting.

Improved Crop Varieties: Farmers in the project area generally use their own saved seed from traditional local varieties which have a limited yield potential. This is understandable, because of the cost and availability of improved varieties, as well as the reduced risk by using well tried local types. However, varieties with a higher yield potential, more drought tolerance and early maturity for a short growing season, will increase output and could be introduced after trials to establish which are best suited to the environment.

Crop Diversification: Reliance on relatively few crop types, especially maize which is not very tolerant of drought, is a poor insurance against losses from drought or disease etc. and there is a need to promote crop diversification by introducing drought tolerant crops like cassava and pigeon pea.

Conservation Farming: The production constraints currently being experienced by farmers growing rainfed crops include unreliable rainfall, lack of labour and negligible use of fertiliser. Conservation Farming (CF) is a relatively new concept which mitigates the effects of these constraints and is being very successfully introduced in several African countries. The basic principle is that of having permanent planting stations in row crops like maize and sorghum, with near-zero tillage between the rows (a single tine ox-drawn ripper is passed between the rows once every 2-3 years). Seed and fertiliser are placed in small basins which are used every year in the same position. Weeds are controlled by applying an herbicide via a simple hand-carried "wipe" applicator. No need for ploughing saves on labour and also permits earlier planting, Zero tillage saves on labour for weeding and also helps reduce soil erosion and rainfall runoff. Fertiliser use is minimised by only applying it to planting stations instead of the whole area. Yield increases of 150% have been experienced where the system has been introduced in other countries, such as Zambia.

Pest Control: Crop losses due to pests in the field and in storage have been estimated as high as 40% and the Mission observed heavy infestations of weevils in stored sorghum. There is need for farmer training in Integrated Pest Management (IPM) which does not rely on purchased chemicals. Farmers can use extracts of Neem and Tephrosia trees which have insecticidal action, as well as chilli, soap etc. to prepare sprays. Stored crops can be protected by mixing leaves of the Neem tree with cobs of maize and heads of sorghum and also by plastering the walls of storage bins with crushed Neem leaves.

The above interventions to improve rainfed agriculture will take place in the Kebeles of the three Weredas (Hamer, Nyangatom and Salamago), which practice rainfed cropping but also rely on flood recession cropping at present.

Assuming that the proposed interventions are thoroughly promoted and that some or all are adopted by 30% of farmers, average yield increases for the major food crops of say: 150% for maize, 100% for sorghum and 100% for beans can be reasonably projected within say 7 years of starting the programme, leading to following foreseeable yields:

Table 6.4: Projected Post-Project Annual Production from Rainfed Cropping

Crop	Area (ha)	Production* (Q/ha)	Total Production (Quintals)	Total Production (Tonnes)
Non-adopting farmers (70%)				
Maize	12,390	7.50	92,925	9,292
Sorghum	12,390	0.75	9,292	929
Beans	12,390	0.25	3,097	309
Adopting farmers (30%)				
Maize	5,310	18.75	99,562	9,956
Sorghum	5,310	1.50	7,965	796
Beans	5,310	0.50	2,655	265

** Based on mixed cropping*

Total annual production for the main food crops from rain-fed areas will therefore be:

Maize	192,487 Quintals	19,248 Tonnes
Sorghum	17,257 "	1,725 "
Beans	5,752 "	575 "

The projected total production of the major food crops will therefore be 21,548 tonnes compared with the pre-project estimate of 15,000 tonnes. This will give each of the 9,250 households estimated to be engaged in rainfed cropping an annual production of 2,320 kg per annum. This is 700 kg more that the pre-project estimate of 1,620 kg per household.

6.2.2.4 Possible Interventions in Irrigated Agriculture

Smallholder irrigated schemes **(***totally financed by Public Developmental Authorities***):** After construction of the dam the number of families that will be interested in and capable of growing irrigated crops can only be a matter of assumption at this stage. However, based on the technical assistance measures envisaged above, the assumption has been made that 20% of those currently engaged in recession cropping i.e. 4,000 families would be involved.

A phased development of 100 irrigated schemes of 20ha (2,000 ha), settled by 80 families with 0.25 ha each, will eventually accommodate these. Location of the 100 schemes will be divided over the four Weredas, in proportion to the amount of flood recession crop area that has been lost.

This relatively small size of scheme (20 ha) is proposed because it will have several advantages; **(a).** It will be small enough to be managed eventually by the smallholders themselves, **(b).** It will be easier to phase construction so that units are operational more quickly, one by one, **(c**). They could be more easily fitted into upstream areas where land levels may be more variable and **(d).** Should a pump break down it will affect fewer people and be less of a disaster.

The cropping pattern for each 0.25-ha plot might be: 0.2 ha grain crops (75% maize, 25% sorghum) and 0.05 ha vegetables, beans and forage crops (proportions of which will depend on market demand). The sorghum is included to cater for traditional uses.

Maize and sorghum will be double cropped and each crop of maize should be capable of yielding 30 Q/ha from the first crop and 20 Q/ha from the second, assuming improved varieties and adequate fertilisation. Sorghum can be expected to yield 10 Q/ha from the first crop and 8 Q/ha from the second using the traditional, long stemmed, white grain type.

These yields may appear conservative, but are realistic under smallholder management. The Omo Valley Agro-Industry Plc at Biralle grows irrigated maize as well as cotton, and averages 32 Q/ha grain.

Crops will be planted as pure stands (not intercropped) for efficient management. Maize and sorghum should find a local market with NGOs and government, to be used in food aid programmes.

Traditionally, milking cows and young livestock are left with the family when the main herd is taken away for grazing and the forage produced will be "cut and carried" to feed them.

Table 6.5: Yields and Production of Irrigated Crops on a 0.25ha Smallholder Plot

Crop	Area (ha)	Yield (Q/ha) 1st crop	Yield (Q/ha) 2nd crop	Yield (Q/ha) Both crops	Total Production (Quintals)	Total Production (Tonnes)
Maize	0.15	30	20	50	7.50	0.75
Sorghum	0.05	10	8	18	0.90	0.09
Vegetables andc.	0.05	na	na	na	na	na
Total Grain	0.25				8.40	0.84

Grain production from each 20ha scheme (80 plots) would amount to 60 tonnes maize and 7.2 tonnes sorghum. The total grain production from 100 schemes would be 6700 tonnes maize and 720 tonnes of sorghum. The amount of grain produced per family – 840 kg - will be about double the amount that a family of 5 persons would require for their own consumption.

Grain crops are usually too low in value to pay for pumped irrigation but as markets for high value crops like vegetables and bananas develop the proportion of these might be expected to increase.

Small Scale Commercial irrigated farms *(partially financed by Public Developmental Authorities)***:** It is anticipated that the more ambitious individuals, with perhaps some management skills, capital and maybe an existing small farm, irrigated by windmill or small pump, would wish to have a larger farm, in effect a small scale commercial unit.

It is assumed, for the purpose of this exercise that 100 such farmers would take advantage of the regulated water supply and that each will have 3 ha of land, on average. They would mainly grow bananas and vegetables as high value cash crops, but also some food crops.

A possible cropping pattern might be: 1.75 ha bananas, 1.0 ha maize and 0.25 ha vegetables. The proportion of vegetables in particular, will depend on market demand.

Table 6.6: Yields and Production of Irrigated Crops on a 3ha Commercial Farm

Crop	Area (ha)	Yield (Q/ha) Maize 1st crop	Yield (Q/ha) Maize 2nd crop	Yield (Q/ha)	Production/farm Quintals	Production/farm Tonnes
Maize	1.00	30	20	50	50	5
Bananas	1.75	na	na	200	350	35
Vegetables	0.25	na	na	200	50	5
Total	3.00					

Production from each 3ha farm would amount to 5 tonnes maize and 35 tonnes bananas Total production from 100 of such small commercial farms will therefore amount to 500 tonnes maize, 3,500 tonnes bananas and 500 tonnes of vegetables.

Large Scale Commercial Farms (*facilitated –not financed- within local development plans by Public Development Authorities):* Extensive areas of level land with a reliable, regulated water supply from the river should attract private investment in large scale irrigated commercial farms or plantations.

Cotton and sugarcane, as well as beef feedlots growing maize for silage, are possibilities, depending on local and export market demand and prices. Omo Valley Agro-Industry Plc., situated not very far away from the lower Omo valley, at Biralle, which was visited by the Mission, is successfully growing 2,700 ha of cotton, irrigated from the Weito River.

Cotton and sugarcane both lend themselves to the contracting of outgrowers, which will provide further opportunities for small-scale farmers.

Feedlots will provide a market for surplus cattle, especially at times when grazing is scarce. It remains to be seen however if the traditional aversion of pastoralists to selling cattle is going to change, although, as mentioned earlier, a recently established livestock market in Omo Rate is attracting traders who buy cattle for sale in the highland urban areas.

Sugarcane is probably the least likely to attract investment initially, because of the high costs associated with constructing a factory, roads etc. as well as the costs of developing a large enough area to justify such infrastructure. Some idea of the water and labour requirements from such large-scale irrigated commercial farms would be as follows:

Type	Water Requirements	Labour (employment potential)
2,000 ha cotton plantation	800 mm/annum over 5 months	125 m/days/ha = 250,000 man days
5,000 ha sugarcane plantation	1,500 mm/annum over 12 months	100 m/days/ha = 500,000 man days
200 ha Beef Feedlot	Maize silage: 600 mm/crop over 4 months -twice a year	300 m/days/ha = 60,000 man days

Locations and areas of interventions in irrigated agriculture**:** All the irrigation development will be situated in the Kebeles which rely on flood-recession cropping at present.

Large commercial plantation schemes will almost certainly be situated in the lower reaches of the river, in Dasenech Wereda, where larger areas of level land are available and the banks are not too high for efficient pumping.

Distribution of small-scale irrigation schemes by Weredas, roughly in proportion to the current amount of post flood cropping, would be as follows:

Table 6.7: Location and Areas of Proposed Small Scale Irrigation Schemes

Kind of Development	Wereda	No. of schemes	No. of farms	Total area (ha)
Smallholder Irrigation Schemes	Hamer 7%	7	560	140
	Salamago 10%	10	800	200
	Nyangatom 18%	18	1440	360
	Dasenech 65%	65	5200	1300
		100	8000	2000
Small Scale Commercial Irrigated Farms	Hamer 7%		7	21
	Salamago 10%		10	30
	Nyangatom 18%		18	54
	Dasenech 65%		65	195
			100	300
Totals				2,300

The anticipated development of commercial plantations will almost certainly be situated on the plains of Dasenech Wereda near the Omo River delta, where large areas of flat land are available. It is not possible at this stage to do more than guess at the number or scale of such investments, but for the sake of argument we can assume that at least 5,000 ha will be developed, with cotton plantations being the most likely.

The proposed interventions in irrigated agriculture will benefit the people in terms of increased food, more cash income and better nutrition.

These will include the creation of irrigation settlement schemes for smallholders, initially managed by the authorities and eventually by farmer associations, financial assistance to individual small-scale commercial farmers, and an enabling environment for large-scale commercial farm development, which will provide employment.

The main developments for irrigated agriculture might be as follows:

(a). Creation of irrigated settlement schemes for smallholders,

(b). Supporting development of individual small-scale irrigated commercial farms,

(c). Providing an enabling environment for large-scale irrigated commercial farming, and

(d). Capacity building of extension services so that they are equipped to assist farmers in the successful development of irrigated agriculture. Activities will basically be the same as for rainfed farming as presented above, with the addition of training in managing irrigation and the operation of water users associations.

Annual production from irrigated cropping, after full implementation of the proposed interventions, is estimated at 6,510 tonnes of maize, 1,230 tonnes sorghum, 3,480 tonnes of bananas and 480 tonnes of vegetables, as shown in the following table. Minor smallholder crops of vegetables, beans, tobacco etc., have not been included.

Table 6.8: Projected Annual Production from Irrigated Cropping - Post-Project

Crop	Area (ha)	Yield (Q/ha)	Production (Quintals)	Production (Tonnes)
2000 ha in 0.25 smallholder plots				
Maize 60%	1200	50	60000	6000
Sorghum 20%	400	18	7200	720
Other crops	400	na	na	na
300 ha in 3.00 small scale commercial farms				
Maize 34%	102	50	5100	510
Bananas 58%	174	200	34800	3480
Vegetables 8%	24	200	4800	480
Total grain production			72300	7230

Comparison of the current production of the main grain crops produced under flood recession cropping with post project recession production is as follows:

Table 6.9: Current Production of Grain Crops compared with Post-project Production

	Maize (tonnes)	Sorghum (tonnes)	Total (tonnes)
Current flood recession production	360	4500	4860
Post-project flood recession production*	291	3638	3929
Post-project irrigated production	6510	720	7230
Increase in grain production			
Without post-project flood recession			2370
With post-project flood recession*			6299

Note: Second line of the table representing the total grain production from residual flood-recession areas, i.e. current recession area (12,000 ha) minus area converted to irrigation (2,300 ha). The assumption made is that flood-recession production continues on such residual areas after the project has introduced 2,300 ha compensation irrigation development. Increase in grain production resulting from the measure alone (2,370 t) will be further enhanced under this assumption, to reach 6,299 t.*

6.2.3 Livestock

Some of the potential interventions meant to offset possible negative impacts stemming from possible difficulties in fully implementing designed controlled floods as planned while generally contributing to improvement of livestock keeping and range amelioration in the Lower Omo area, as suggested by both pastoralist and Wereda technical staff will have to focus on the following sectors:

- Rangeland development and management;
- Improvement of the veterinary services
- Provision of adequate watering points for livestock in inland rangelands
- Forage improvement and development (including Livestock Enterprises)
- Amelioration of local livestock breeds

Amongst these, a number of related activities have been conceived, and are presented below. The livestock development project profiles and the associated implementation costs are presented in Appendix 4.

6.2.3.1 Livestock Forage Production on Individual Irrigated Agricultural Holdings

Livestock Forage Production on Individual Irrigated Agricultural Holdings is to be implemented in Dasenech, Hamer, Nyangatom and Salamago Weredas, where irrigated agriculture will be practiced.

This intervention will focus on integrating forage cropping with agriculture in order to supplement livestock with green feed, especially in the course of the dry season, when natural pasture would become scarce.

It will be based upon Technical Assistance, training, and extension from Weredas, as well as provision of improved forage seeds and other materials tools and fertilisers). This activity will further establish demonstration plots along the Omo River.

6.2.3.2 Irrigated Forage Development

Irrigated Forage Development further in-land along the Omo River (Livestock Enterprises) would target rangelands in the immediate proximity of the Omo River for improved livestock production, where availability of forage is mainly attributable to river flooding, and where potential disruption of floods would decrease forage quality and quantity availability.

The action will increase productivity of forage on communal grazing lands by irrigating suitable portions of land and will contribute to profitable livestock activities (fattening).

The provisional target is of about 1000 ha for each of the 4 Weredas, within Kebele units of some 100 ha each.

6.2.3.3 Range Development and Management in the Delta

Range Development and Management in the Delta would take place mainly within Dasenech Wereda, in the Omo river delta area, inclusive of delta islands. This may be necessary in case disruption of artificial floods may no longer fully contribute, by adequate submersion, to rejuvenation of grasses (mainly elephant grass) and vegetation presently heavily utilised by livestock for most of the year (instead of allowing year-round free grazing on all delta islands).

The action will introduce proper management regimes of rotational grazing, subdividing isles into natural paddocks and conserving part of the produced biomass for later use, thus improving biomass production, avoiding rangelands degradation, improving conditions and productivity of livestock, and by training of livestock owners and technical staff.

6.2.3.4 Improved Livestock Practices

Indigenous livestock in the watershed are numerous and scarcely productive; objectives of this action will include improvement of productivity, contribute to overcoming shortages of animal health facilities, reduce incidence of animal diseases, and increase production and availability of fodder by facilitating establishment of Animal Health Posts, improving local livestock breeds (introduction of Borana and Sheka breeds), providing additional inland watering points, strengthening extension services.

Design of water sources will make provision for rotating their use so as not to cause over-utilisation and degradation of natural pastures. About 8000 livestock owners would be targeted by the action.

6.2.4 Dipa Hayk

Dipa Hayk is a lake that its shore is used by the Karo community for recession cultivation, grazing resources and the lake water for fishery. During the month of July to September the Omo River floods and fills the Dipa Hayk. This creates the opportunity for the Karo community to plant crops around the lake shore using recession cultivation for their subsistence need and they also fish from this lake. Hence the reduction in flood flow to Dipa Hayk will adverse impact the community in terms of reduced crop harvest gain, fishing and availability of grazing for their livestock.

However, as discussed above, during the survey it was confirmed that Dipa Lake which is seasonally swamped by the river through an artificial channel was largely impounded at the date of the visit after the occurrence of the first peak of the 2008 wet season (See picture 27). Therefore, the release of the “controlled flood” from Gibe III will fill the Lake and avoid the potential adverse impacts to the local community.

6.2.5 Riverine Woodlands Vegetation

Controlled releases, besides providing the high-pulse for fish stock reproduction, will sustain sufficient vegetal biomass increase in downstream riverine environments. Picture 34 shows the riverine forest that is flooded following the first high flow period of the year. Therefore, the presence of soil moisture to the lowland riverine vegetation (forest) will also be guaranteed by the release of wet-season controlled flood and the potential adverse impacts on the riverine woodlands will be avoided.

Picture 33: (Photo N. 63) - UTM: East 189,891; North 571,257. Dipa Lake (470 Km d/s of Gibe III). 20 July 2008

Figure 34: Photo N. 30 - UTM: East 167,712; North 517,533. (720 Km d/s of Gibe III). 20 July 2008

6.2.6 Other Socio-economic Developmental Activities

The annual regulation of the river will bring about overall benefits as previously explained, while artificial flooding will occur only for pre-set periods of time of which local people will be made aware of in advance.

In case the annual release does not fully succeed as scheduled, some other compensation measures could be implemented and these are briefly discussed below. The recommended socio-economic development projects and the implementation costs are presented in Appendix 6.

Adverse impact	Mitigation and compensation measures
1.Possible unexpected changes of traditional lifestyle and production system	**Community awareness program** concerning possible short, environmental changes and feasible production alternative support; Elaboration of an efficient **information system** for the project area inhabitants;
2. Possible (short period) households minor income reduction	Livelihood economy diversification training and accompanying program. Facilitate **cooperative creation** trough a specific capacity building program and technical assistance program. Agriculture in service training program for Farmers Training Centre (FTC) personnel. Coordination measures for food aid
3. Possible increasing human and animal pressure on the riverine area Conflict between: Population – local authorities and between Breeders and farmers	Regular **information meetings** between project management and affected Wereda officials for sharing information on water management **Conflict prevent and resolution** training programs for Wereda and affected Kebele officials Wereda institutions strengthening Capacity Building for EMU

Community awareness program: A focused Community Awareness Program for the riverine affected Kebeles should be set up through a detailed feasibility study, with the objective of clearly identifying beneficiaries, activities and timing. The principle objective remains informing the possible affected population concerning potential production system changes, and supporting them to identify feasible alternatives and other accompanying measures.

Information system: An information strategy for the construction phase is largely explained in other sections of this report. The information strategy is based on the principle that only fully and correct information sharing both toward and from beneficiaries can prevent local conflicts and can ensure a sustainable adaptation of local people to eventual environmental changes. The objective is to monitor environmental and socio-economic aspects with full participation of the local inhabitants.

Cooperative support: A pertinent important measure would be providing support to bottom-up peasant's cooperatives or associations with the objective to enhance the household living conditions as well as their agricultural production. A specific capacity building program should be designed in close connection with the "Agricultural in service training program" mainly dedicated to the Peasants Training Centre (PTC) trainers.

*Agriculture in-Service Training Program***:** Still in terms of farmers support, an in-Service Training Program primarily dedicated to the PTC' trainers will have a wide effect on the Wereda farmers. The objective of this training program is to enhance the capacity of the PTC to respond to the farmer's needs and support farmers during the construction and post-construction phase.

Coordination measures for food aid: Food aid distribution often represents as much as 50% of the inhabitants livelihoods. The coordination of the monitoring activities with the Regional Food Security program is a must and should be taken in due consideration by the EMU.

Regular information meetings: A system of regular information meetings between EEPCO management and Wereda officials for sharing information on water management will be set-up. Even though this measure doesn't involve funding, it must be implemented in order to allow stakeholders to be informed and act accordingly. This measure will be included in the Environmental Monitoring Plan.

Conflict prevention and resolution's training program: This mitigation measure is planned to prevent possible inter-ethnic or inter-community conflict due to the increasing human and animal pressure on the riverine area. A further detailed study will be designing a focused program that could be implemented at Kebele level.

Wereda institutions strengthening: A tailored institutional strengthening program can complete the framework of the suggested local actions toward both local people and public institutions, to help them cope with some possible changes due to the GIBE III project. Strengthening Wereda official's roles can become an important objective that will be detailed by a feasibility study for each single Wereda to identify actions, resources and timing.

Capacity Building for EMU: In accordance with both the EIA Main Report and the meeting held by the Mission with the EMU Coordinator in Addis Ababa, EMU's staff training is an important strategic and operational issue in planning the GIBE III operational framework.

The role of EMU and its field branch "the GIBE III Information and Monitoring Coordination" should be fundamental as the governing institution for the Environmental Monitoring Plan design and implementation.

7 ENVIRONMENTAL MANAGEMENT PLAN

7.1 General Considerations

As clearly mentioned by the EIA's main report, the Environmental Management Plan (EMP) must be fully integrated with the overall Project Management and, as such, its effective planning will be EEPCO overall responsibility. Its aim is to develop an efficient implementation instrument but above all to be a dynamic support tool accompanying both the construction and post-construction phase.

For this reason this report assigns an important role to the accompanying management and monitoring aspects as detailed below.

The EMP will thus assist Project planners and Government Institutions in their decision-making processes by making sure that established operations guarantee transparent and ready implementation of identified mitigation measures.

The EMP will comprehensively cover management of relevant aspects dealing with actions related to the natural and human environment so that potential adverse impacts will not materialise, to create hazards or negatively affect the quality of life of future generations.

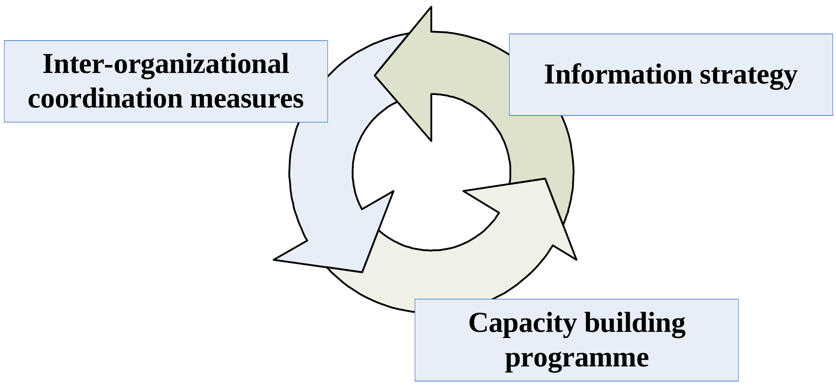
As such, the Environmental Monitoring Plan should not be seen as a separate entity from the overall Environmental Management Plan of which it represents, instead, a substantial component.

7.2 Proposed Organisational Set-up

An efficient planning and implementation of the Environmental Management Plan during the construction phase is fundamental both for environmental aspects and socio-economic issues.

EEPCO will have executive responsibility for ensuring that all relevant aspects will be considered in the Environmental Management Plan, thus a management concept comprising three sub-components is hereby proposed:

- A specific information strategy
- A clear framework of inter-organizational coordination measures
- A tailored capacity building program



The organization in charge of coordinating and managing the Environmental Management Plan has been identified in EEPCO'EMU (Environmental Monitoring Unit). According to EMU's coordination role, a specific *Gibe III Information and Monitoring Coordination unit* could be set up for the entire construction and post-construction phases.

The team, composed of multi-sectoral experts will be divided into two sub-groups; one mainly based at EEPCO's Headquarters while the other will be permanently placed in the field, constituting the *Information and Monitoring Centre***.**

7.2.1 A specific information strategy

The information strategy is based on the principle that only full and correct information dissemination both toward and from beneficiaries can prevent local conflicts, and assure a sustainable adaptation of local people to potential new environmental conditions and changes.

The *Information and Monitoring Centre* at the South Omo Zone's level under the responsibility of the Gibe III Information and Monitoring Coordination Unit will take responsibility for ensuring that this strategy is implemented at field level.

The Information and Monitoring Centre will comprise Gibe III Information and Monitoring Coordination personnel together with seconded Zonal officials to cover all rural development and environmental aspects.

The specific role of this Centre will be to gather, analyse and monitor, under supervision of the Unit in Addis Ababa, the following types of information:

Biological and Hydrological information and data: inventory and monitoring of natural and floristic parameters of aquatic and terrestrial ecosystems, both as baseline and as a routine activity for the post-construction phase; hydrology and water resources features and trends including periodical monitoring to inform and support technical and administrative decision-making as well as the various stakeholders.

Socio-economic information and data: compilation and monitoring of existing statistics and economic data on agricultural and livestock production and activities in the zone; analysis of the economics of such activities; income statistics relating to different social groups in the valley. Periodical monitoring will also be carried out to inform administrative authorities about goods and raw material prices, income and employment and eventually health problems linked with current events.

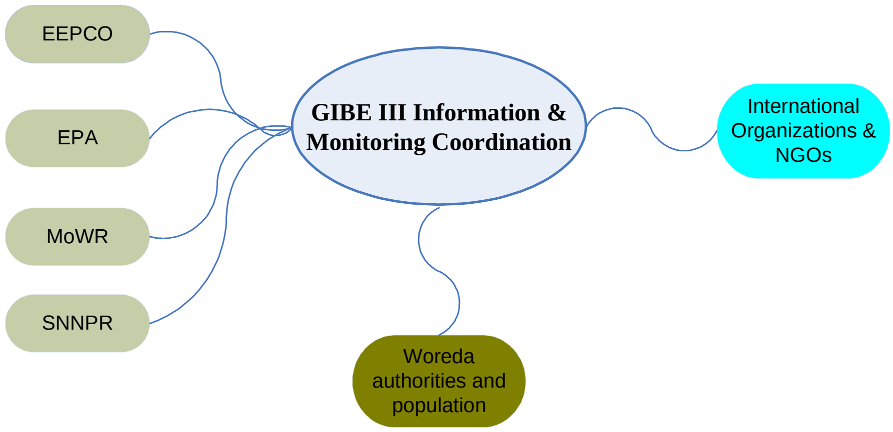
The primary role of the *Information and Monitoring Centre* will therefore be that of providing a central information resource, allowing a more balanced and updated view of the factors interacting within the Lower Omo Valley so as to allow developing alternatives especially concerning water management proposals.

In addition, the centre will provide active institutional support in the capacity building of local organizations, and will assist water users' groups in generating ideas for new technical methods and ways of organizing water users.

7.2.2 Inter-organizational Coordination Measures framework

The GIBE III Information and Monitoring Coordination Unit will be also in charge of facilitating and ensuring permanent information and coordination amongst the institutions-level stakeholders, as shown in the following diagram and better explained under the heading " Institutional Responsibility" below.

Diagram 2: Proposed coordination and information at the institutional level



This may represent an institutional arrangement linking different organisations having a stake in the Project. On the left side are national public authorities that must be informed about the project, during both the construction and operation phase and on the right side, international and national organizations, and international NGOs operating in the Omo River Basin.

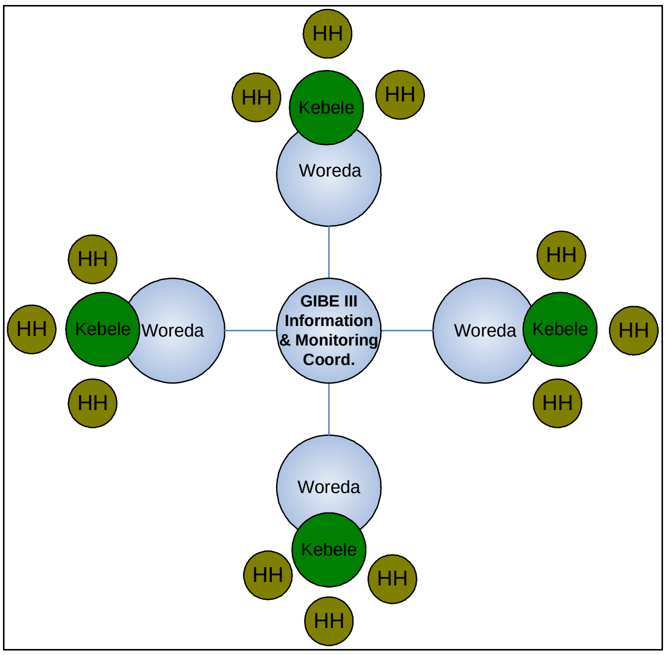
Eventually, at the bottom of the diagram are included the different Weredas, authorities as representatives of the local populations' rights and interests.

The information flow (records and progress reports) comprises follow-up information of the construction phase, as well as problems or information to be shared with the different stakeholders.

Whilst the diagram above may represent coordination and information at institutional level, the diagrammatical scheme proposed below will underline information and coordination flow at the local level.

The diagram highlights the two-way information flow between the centre and final users. As we previously stressed, correct and timely information to the beneficiaries can effectively prevent conflicts, both within and among communities, and between Wereda authorities and communities, and in particular is meant to mitigate households' economic damages due to environmental changes.

Diagram 3: Information and Coordination framework at local level



7.2.3 A Tailored Capacity Building Program

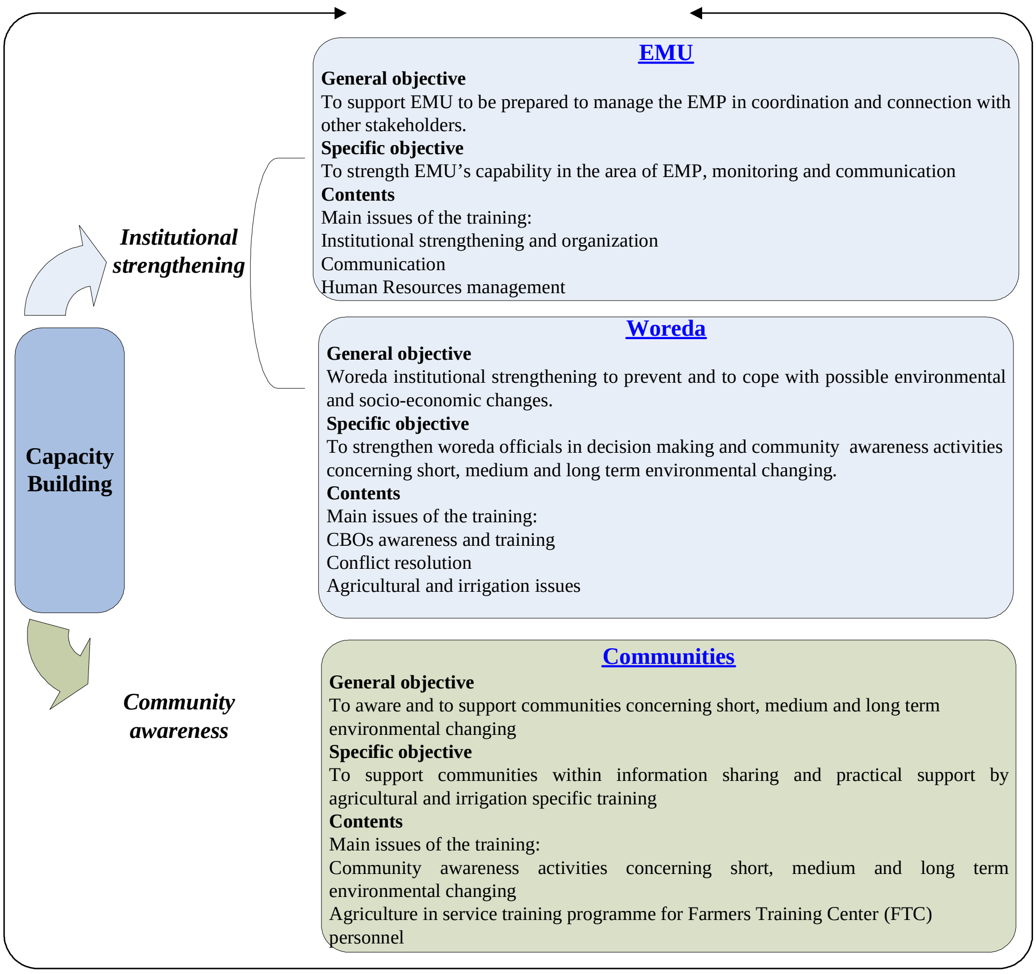
The third pillar of the EMP in the construction phase will be the design and implementation of a tailored capacity building program (CBP) for the various stakeholders along the entire phase.

All stakeholders involved in the project must have support through capacity building programs. This CBP will be designed for the different target groups by specific institutes, universities or consultancy companies specialized in environment, training, human resources management and change management.

National-international consortium building (University-consultancies or International University-local NGOs) is expected to enhance knowledge and mobilize different external know-how's.

The following diagram illustrates the strategy to support the three main target groups: EMU as the coordination institution, Weredas as intermediary administrative authorities and communities as the final target groups.

Diagram 4: Proposed Capacity Building Program Strategy



7.3 Assistance to Vulnerable Groups

Capacity building measures to assist the vulnerable groups could be developed in a stand-alone project that will be substantially based on assisting vulnerable groups (women, young, elders) in order to cope with some unexpected changes that may potentially arise as a consequence of the Gibe III construction and operation.

It is possible to divide the vulnerable groups into two categories:

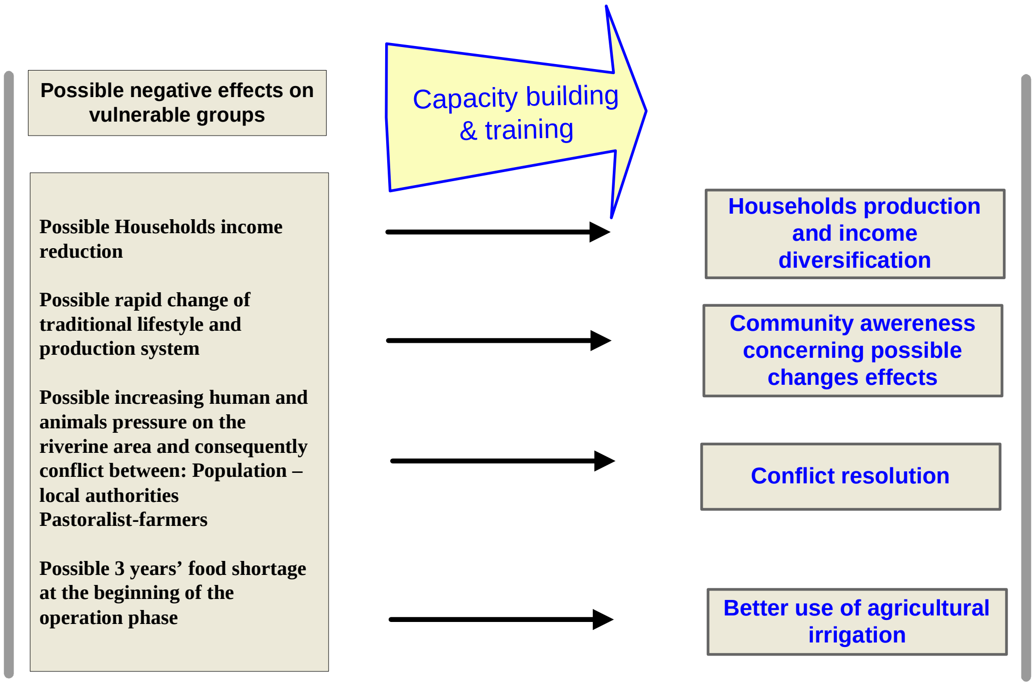
Women, youth and elders of communities non-directly influenced by the project development (watershed level), though indirectly vulnerable to events possibly provoked by some unforeseen rapid environmental changes.

The second group will mainly include potentially directly affected (riverine) Kebele households.

While the first group will be subject to monitoring at lower Omo watershed level, specific lines of action would need to be planned in respect of the second group (riverine communities) potentially directly affected in order to mitigate effects such as:

- Possible household's income reduction (there is a very small economy and money flow. The quantity of products exchanged will decrease) and food shortages;
- Possible rapid change of traditional lifestyle and production systems; and
- Possible increasing human and livestock pressure on the riverine area and consequent conflicts.

Diagram 5: Capacity Building Program Strategy



The aforementioned issues representing a possible strategy to support vulnerable groups through a capacity building program that could be carried out by local expertise, EMU personnel, consultancy firms or training institutions depending on the specific training course focus.

7.4 Proposed Institutional Responsibility Sharing

An in-depth assessment of strengths and weaknesses of all involved stakeholders is a pre-requisite to fully comprehend the institutional framework within which the Gibe III project will be called upon to operate.

While a comprehensive assessment at a project feasibility level would still need to be locally executed under a participatory approach, the matrix below may be provisionally utilised as a reference element for the sake of the present study.

It proposes some groups amongst the primary, secondary and other (external) stakeholders, identifies their interests and gives a sketchy assessment of possible involvement with the project with respect to their respective interests and priorities.

The same model may also be used to furnish a picture of possible expectations and strategies towards project implementation, objectives and results. The (+) signify levels of involvement on a value scale of importance, while numerical values identify different priorities of interest attributable to stakeholders.

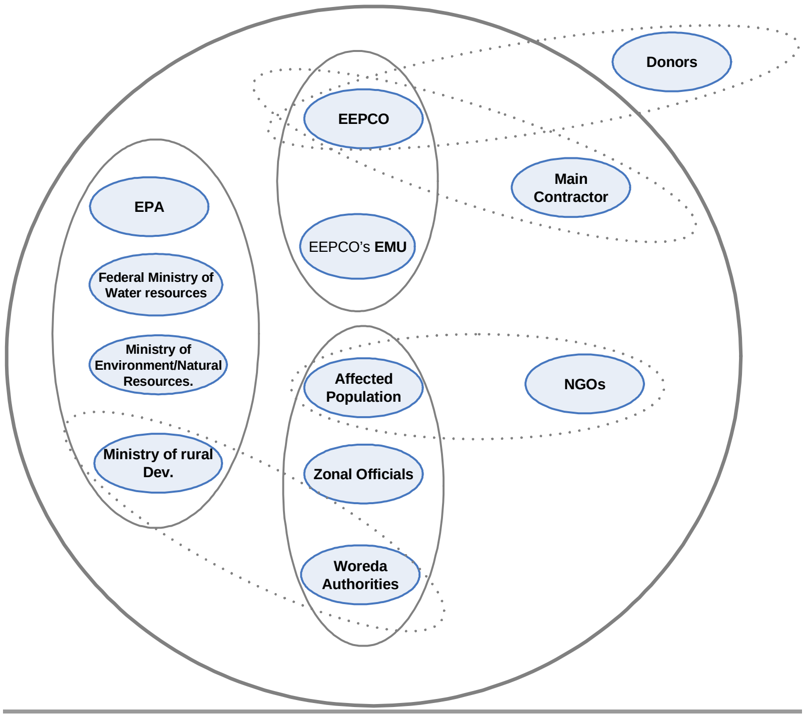
Table 7.1: Stakeholder Analysis Matrix for the Gibe III downstream Study

Primary Stakeholders	**Interest**	**Potential project involvement**	**Relative priority of interest**
Environmental Protection Authority (EPA)	Compliance with, and respect of established national and international environmental standards;	+++	4
Ethiopian Electric Power Corporation (EEPCO)	Project accomplishment without inter-organizational conflicts;	+++	5
EEPCO's Environment Monitoring Unit (EMU)	Addressing efficiently environmental matters arising from the development program;	+++	4
Wereda authorities	Guarantee and enhance the relevant Wereda's natural environments and inhabitants livelihood;	+++	4
Local Population	Preservation of natural resources and socio-economic enhancement;	++++	5
Secondary Stakeholders	**Interest**	**Potential project involvement**	**Relative priority of interest**
Zonal level Offices of Agriculture	Ensure the affected Kebeles' inhabitants livelihood	+++	4
Federal Ministry of water resources (MoWR)	To guarantee conditions and methods required for the optimum allocation and utilization of water at both national and regional level;	++	3
Ministry of Rural Development (MRD) Particularly the Food Security Department	To guarantee the actual livelihood standards and be regularly updated in order to monitor food security distribution at Kebeles level;	+++	3
External Stakeholders	**Interest**	**Potential project involvement**	**Relative priority of interest**
NGOs	To keep informed and to influence public opinion and local authorities concerning the project's beneficial and adverse impact; contribute to developmental process;	+	1

A solid comprehension of the sub-systems is needed to allow for the final design of appropriate mitigation and compensation measures and for their effective implementation.

The following figure represents the inter-organizational relationship where Gibe III project will be likely to operate:

Diagram 6: System map of inter-organizational relationships in the framework of the GIBE III DAM project



7.5 Information and Communication Strategy

Within the valley, the project will increase the quality and availability of information about technical and institutional aspects of territorial management.

The project will collate existing data, and undertake studies to fill information gaps. Communication activities will make this information widely available.

Institutional work will include support to the formation of farmers' organizations to ensure that poorer farmers are both aware of their legal rights, and able to express their interests in the decision-making process.

Particular emphasis will be placed on the 'easy access to the information for small-scale-farmers' through cooperatives and local organizations.

Regularly held meetings in which relevant information will be exchanged will ensure solid communication, representing an important component of the management and monitoring feedback system.

7.6 Daily Flow Variation Acoustic Warning System

As highlighted elsewhere within the present report, the first section of the river downstream Gibe III dam will experience consistent fluctuation of water levels within the riverbed in the course of normal (24 hrs) hydroelectric operations. Although, due to local geomorphology, no permanent human settlement / activities are located in areas interested by the fluctuating water levels, this does not mean that humans, especially in the proximity of villages, may not approach the river for different usages or for crossing it.

To this aim, a long-term warning system constituted by sirens will be placed and operated in river sections located in the immediate proximity of nearest villages and around major river crossing to signal in advance occurrence of rising waters in a number of priority spots (provisionally estimated in 50 – 100 locations) along the Omo river first 200 km downstream Gibe III Dam.

The sirens will advice differently for *Large Water Releases* (Controlled Floodings) and *Ordinary Discharges* occurring daily as a result of Dam operations by mean of distinct warning signals to the understanding of which the residing population will be trained beforehand.

The Warning Units will be remotely trigged by the Dam Control Station, on a pre-organised time sequence according to the river water speed, possibly coupled with water level gauges systems reacting to rising water levels placed in the immediate proximity of warning units.

Sonic Devices and water level gauges with ultrasonic sensors will be operated by solar panels.

7.7 Reporting and Reviewing

According to the above Information and Communication Strategy, an efficient multi-stakeholder's reporting system should be implemented during the construction and post-construction period. The two main sources of information should be both the *Gibe-3 Project Main Contractor* and EMU through the *GIBE III Information and Monitoring Coordination Unit*.

The first will mainly be in charge of constantly informing the EMU and Federal and local authorities regarding GIBE III project's technical progress. The latter through the *Information and Monitoring Coordination Unit* will be in charge of informing the different stakeholders.

Concerning quarterly reports, they should be of two different types:

The main Contractor reports containing dam construction follow-up information based on technical issues, to record an understanding of the project progression;

The EMU's GIBE III Information and Monitoring Coordination Unit information flow will contain the monitoring information on relevant issues such as: natural resources, agriculture, livestock, fishery, health, household income and local market flow.

8 ENVIRONMENTAL MONITORING PLAN

8.1 Overview of the Monitoring Plan

Environmental monitoring is an essential tool in relation to environmental management as it provides the basis for rational management decisions regarding impact control. By using the information collected through monitoring, environmental mitigation and benefit enhancement measures can be improved and the works or operation will be modified or halted when necessary.

Therefore, the objectives of this environmental monitoring programme include:

- to monitor changes in the environmental conditions by the construction and operation of the Gibe III Project;
- to check on whether mitigation and benefit enhancement measures have actually been adopted, and are proving effective in practice;
- to provide a means whereby any impacts which were subject to uncertainty at the time of preparation of this additional ESIA for the downstream area, or which were unforeseen, can be identified, and to provide a basis for formulating appropriate additional impact mitigation measures; and
- to provide information on the actual nature and extent of key impacts and the effectiveness of mitigation and benefit enhancement measures which, through a feedback mechanism, can improve the planning and execution of future, similar projects.

The environmental monitoring plan outlined below and summarised in Table 8.1 describes the particular resources that will be monitored through operation phases of the project.

8.2 Components of Environmental Monitoring

8.2.1 Monitoring to Establish Baseline

Planning of downstream monitoring activities will also be EEPCO's responsibility and will include development and implementation of a Baseline Monitoring Programme against which annual monitoring will later on be referred.

This Programme is to comprise the layout of a river hydrodynamic model, which will duly consider links between the present flow regime and all related ecosystem peculiarities for the different sections of the river and its surroundings, including biological aspects of the estuarine floodplains.

Incoming / actualised data will help to evaluate appropriateness (effectiveness and efficacy) of the proposed mitigation actions including environmental water releases, thus providing elements to update its operational aspects and substantially contributing to adaptive environmental management.

For the above needs, it is here important to mention that the present study necessarily represent a preliminary set of information and data reported at the reconnaissance level. Therefore, it is recommended for EEPCO to set-up an environmental and social monitoring system at the lower Omo.

This will be a first step to guide the establishment of a proper baseline information databank for the Lower Omo which needs to be laid out in detail at the feasibility level and subsequently executed by EEPCO, to include identification and monitoring methodologies for relevant:

- Physical aspects;
- Ecological aspects;
- Socio-economic and ethnographic aspects;

While development of specific terms of references and implementation details are beyond the scope of the present study, the table below furnishes a useful reference for identifying in broad terms the overall package of environmental monitoring indicators that will need be studied in relation to the Project, both as part of the baseline study as well as for a period of at least 5 years after completion of the Gibe III dam.

This monitoring regime should begin at the earliest and some of this monitoring can be included in the ongoing activities of government agencies already active in the project area and some will be carried out by EEPCO or organisations appointed by it.

The cost of monitoring to establish baseline environment is estimated to be 1.5 million and will be covered by EEPCO.

8.2.2 Monitoring Plan

Impounding will follow construction and when the necessary tests are completed operation phase (energy production) will start. Monitoring will be an integrated part of operation of the project to comply with the standards and improve management practices.

The principal fields of interest requiring monitoring during operation phase are summarized in Table 8.1.

Table 8.1: Environmental Monitoring Plan

Parameters to be monitored	Reasons for monitoring	Monitoring location	Monitoring method	Frequency (5 years period)
Physical Indicators				
Baseline Water Quality (pH, SS, BOD, DO, total nitrogen, total phosphorus)	Establishment of Baseline Data and successive trends	Downstream Gibe III, Stations every 200 km	Chemical analysis	Bi-monthly
Downstream water flow	Ensure planned environmental flow and artificial flood	Gibe III outlets	Gauging boards	Daily
Erosion of riverbanks	Avoidance of environmental degradation	10 km interval observation points and at selected meanders	Visual inspection	Yearly
Land Cover	Baseline and trends	Strip 20 km wide along river and delta area	Satellite image interpretation	Yearly
Recession agricultural soils fertility analyses (structure, texture, ph, OM, N total, P2O5, K2O)	Baseline and trends	Sampling on flooded areas	Soil sampling, chemical analysis	Every two years
Biological Indicators				
Commercial fish species	Establishment of Baseline Data and successive trends	Omo River and Tributaries downstream Gibe III, Lake Turkana	Gillnets and seine nets, catch surveys	Twice yearly
Aquatic Invertebrates	Baseline and trends	Same as above	Vertical net haul and grab samples	Yearly
Aquatic macrophytes	Baseline and trends	Same as above	Visual survey by aquatic botanist	Yearly
Malaria vectors	Baseline and trends	Seasonal swamps and river delta	Visual survey by invertebrate biologist	Yearly

Parameters to be monitored	Reasons for monitoring	Monitoring location	Monitoring method	Frequency (5 years period)
Malaria incidence	Baseline and trends	4 Weredas	Clinics records	Yearly
Watertable	Baseline and Ensure no future depletion and levels	Boreholes on a strip 5 km wide along river and in the delta area	Measure water table height using dipper	Bi-monthly the 1st year, and twice a year afterwards.
Terrestrial Wildlife (flagship species only)	Baseline and trends	Strip 30 km wide along river and delta area	Visual survey	Twice a year
Terrestrial Birdlife	Baseline and trends	Riverine and riparian environments	Visual survey	Twice a year
Terrestrial Riparial Flora	Baseline and trends	Riverine and riparian environments	Visual inspection by botanist, transects	Yearly
Social and Economic Indicators				
Agriculture: riverbank and floodplains extension and productions; input supply, sale prices	trends	Strip 20 km wide along river and delta area	Land Cover updating, Wereda records	Yearly
Livestock: consistency, localisation, migration, feed sources and health conditions.	Baseline and trends	4 Weredas	Survey by Livestock Expert, Wereda records	Yearly
Changes in food consumptions, incomes, health status, quantity of market sales, water uses for Agriculture	Trends	Strip 20 km wide along river and delta area	Survey by Socio-economic Expert, Wereda records	Yearly
Tribal issues and sources of conflicts	Trends	4 Weredas	Survey by Anthropologist	Yearly

It is therefore vital that environmental monitoring plan activities will make allowance, as planned, for including the above specific provisions aimed at effectively monitoring biological conditions downstream of the Gibe III Hydropower Plant, in terms of tasks assignment and shared responsibilities amongst responsible entities for biological monitoring during the construction and operation phase.

8.2.3 Monitoring and Managing Soil Fertility in Flooded Agricultural Areas

Of particular relevance will be monitoring and managing soil fertility within flooded agricultural areas with the view of ensuring future sustainable agricultural production at least on the same levels of that attained at present.

For this reason the project, while assuming that in the short-term natural soil fertility of alluvial plains[1] (where most of recession agriculture takes place) and suspended fertilizing elements present in the planned controlled flooding water will continue guaranteeing a sufficient degree of productivity of recession agriculture, has planned for both a bi-monthly monitoring campaign of water quality and the implementation of regularly executed soil fertility surveys for determination of present and residual fertility.

Water quality (total suspended solids) sampling campaign in the Omo River has already started (see Appendix 7. for details); this campaign, if carried out bi-monthly before and after Gibe III establishment for a minimum of 5 years as planned, giving details on nutrients quantification, and possibly their average sedimentation time will provide further elements needed for a correct indication of required flooding duration and sediments available for soil fertility downstream.

[1] Omo Valley Agro-Industry Plc at Biralle attains productions of some 30 Q/ha maize with no chemical fertilisation, based on natural high fertility of soils and limited nutrients deriving from irrigation water.

In the mean time, current soil natural fertility, at present not known at all required stations, will be ascertained on inundated / recession agriculture areas identified by this study (see attached Land Use Map) through a full-scale feasibility level soil analysis campaign, with residual fertility monitored on a constant basis every two years afterwards.

The interpolation of the above data, when confronted with approximate nutrients removal by crops according to present / desirable yields will give an appropriate indication of the extent to which artificial flooding will be (possibly) called to integrate natural fertility, thus permitting adjustments as needed or integration with artificial fertilizing.

Table 8.2: Approximate nutrient removal and requirements by tropical crops

		Removal of nutrients in kg/ha			Range of minimum–maximum nutrient applications in kg/ha		
Crop[a]	Yields in metric tons/ha	N	P_2O_5	K_2O	N	P_2O_5	K_2O
A wheat	3·0 (grain) and 3·5 straw	70	30	60	75–90	35–50	35–75
A corn (maize)	4·0 (grain) and 6·0 (straw)	200	80	160	60–100	50–100	75–100
A rice (paddy)	4·0 (grain) and 6·5 (straw)	60	30	90	75–100	25–50	25–50
A cotton	2·0 seed cotton	90	60	135	50–100	25–50	25–75
A jute	1·0 fibre	50	40	160	60–90	35–60	75–100
A potatoes	25·0 tubers	115	45	200	50–100	50–100	75–150
A cassave	25·0 tubers	125	30	150	50–90	60–75	80–120
A sugar-beet	40·0 roots 10·0 tops	150	60	200	75–100	50–75	100–120
A sugar-cane	90·0 cane	85	60	180	75–100	60–100	75–100
A tobacco	2·5 barn-dry leaves	50	15	125	very variable		
A soybeans	2·0 grains	(125)	30	40	0–25	35–60	35–75
A groundnuts	1·0 unshelled	(50)	15	15	0–25	50–100	35–75
A alfalfa	80·0 green	(320)	60	180	0–25	90–150	100–200
B banana	30·0 fruits	60	15	200	50–90	60–100	150–250
B citrus	15·0 fruits	100	25	145	100–150	60–100	100–200
B cacao	1·0 beans	20	10	15	35–60	25–50	55–75
B coffee	2·0 unshelled beans	30	5	48	35–60	25–50	75–110
B tea	1·0 dried leaves	90	15	35	35–60	25–50	45–75
B rubber	1·5 dry rubber	40	10	25	25–45	20–35	0–35
B oil palm	15·0 bunches	90	20	135	25–35	20–35	35–110

[a] A=annual crops, B=perennial crops, full productive years.

8.2.4 Fishery Resources Monitoring Plan

Monitoring Plan: Under the new hydrological environment, (in spite of the measures taken) certain changes would be expected in the productivity of the riverine and lacustrine environment. It is therefore, necessary to follow up and monitor changes through recording certain parameters. The main objective of the monitoring plan is to follow up possible changes in the downstream and lake environment so as to take the necessary corrective measures when required.

The decrease in nutrient input into the downstream Omo and the Lake Turkana environment (from the reservoir) would be one factor that could affect (reduce) the water productivity.

- At the Lake Turkana water level fluctuations and shrinkage of shore areas would be recorded to monitor changes that may affect the breeding grounds of some important fish species. - Water level recording at the lake,
- Sampling and analysis of macro-invertabrates bi-annually,
- Quarterly sampling for phytoplankton to check on the composition and density,
- Bi-weekly measure of oxygen levels, and
- Sampling and recording fish catch - species composition, size distribution (measure length and frequency by species).

Organization setup: It is necessary to establish one “Data Collection and Monitoring centre” with skilled technicians and basic sampling and measurement equipments at Omorati.

The main centre could serve as an important facility with multidisciplinary technical staff to undertake fishery data collection, provide technical support to fishers, coordinate training programs and enhance the extension service that should help the fishers.

Sub-stations with less capacity will be placed in other Weredas and staffed with DA's that also perform other agricultural activities.

The main centre could be linked to the Fishery Research at the University of Awasa and the Regional BoA to get proper technical and professional backup as required.

8.3 Monitoring Framework

The primary responsibility of this monitoring plan is of EEPCO who is the Project Developer. The Gibe III Environmental monitoring plan will be administered within EEPCO's project coordination office. Effective monitoring of all stages of the project could be managed through the Environmental Management Unit (EMU). The principal aim of the EMU would be advising the project authorities and local administration about the best practicable means for protecting the environment during all stages of the project's life span. It would provide EEPCO and station operation managers with concrete proposals for monitoring the environment, and indicate operational procedures for protecting the environment.

EMU will begin the implementation of the programme by forming team of specialists to assist in monitoring the environmental effects during construction period. The team members would be chosen from local scientists and will include the following specialists: Limnologist, Terrestrial Ecologist, Fishery Expert, Sociologist/Resettlement Planner and Public Health Expert on part-time basis. Furthermore, independent external environmental monitoring may also be considered by EPA for the activities that are not under the responsibility of the EMU.

In addition, there are other agencies that have the responsibility and authority to monitor some of the measures. It is also recommended that EEPCO involves other Agencies (including EPA) and subcontractors as required to form the environmental management team.

During operation phase, it is recommended to carryout a formal audit (once every three years) of environmental and social performance by an independent body.

9 ENVIRONMENTAL MITIGATION, MANAGEMENT & MONITORING COSTS

9.1 Implementation Cost of ESMP

The total environmental costs are summarised in Table 9.1 and amounts to some ETB 281.8 million. This amount will be allocated to cover implementation of the environmental mitigation, management, monitoring and training programmes described in Chapter 6, 7 and 8 respectively. The implementation schedule is given in Figure 9.1.

The cost estimate has made adequate provisions for contingencies and it has been considered as a component of the financial requirement of the project.

Brief description of the various cost items are presented below:

i. ***Development of flood recession agriculture:*** Various interventions are proposed to offset possible negative impacts stemming from possible difficulties in fully implementing designed controlled floods as planned. Together with this measure, more support actions are proposed for recession agriculture and meant to increase productivity and attain self-sufficiency in the lower Omo.

ii. ***Irrigated agriculture:*** the project would assist the lower Omo population by implementing and promoting small scale irrigation schemes.

iii. ***Livestock production:*** Rangeland development and management, forage improvement and development, improvement of the veterinary services, and improved livestock practices.

iv. ***Fishery development:*** Expanding and developing the riverine and lake fishery to bring more income and improve the livelihood for the community. This requires inputs in terms of improved technical skill, fishing materials, infrastructure, processing, storage, transport and fish market facilities.

v. ***Socio-economic support programme:*** Since not only economic opportunities (other than traditional and subsistence farming), but also technical and business skills among the Lower Omo populations are very low. Therefore, they will be supported by the project through training, facilitation and capacity building so that they can set up profitable ventures. In addition to capacity building (at community and Wereda level), the Project would also finance livelihood economy diversification support programme and agriculture in service training for Farmers Training Centre (FTC). Under this programme, cooperatives will be established and capacity building and technical assistance will also be provided.

vi. ***Installation of flow variation acoustic warning system:*** "alert and danger" posts and acoustic signals shall be provided downstream of the dam to alert/inform about abrupt release of waters to the downstream communities. The cost is estimated to cover 50 -100 locations.

vii. ***Food aid during reservoir filling:*** The food aid is to compensate for the loss of flood recession cropping until such time their source of livelihood has been restored. It will be required during reservoir filling and before the start of controlled flooding.

viii. ***Establishment of Data Collection and Monitoring Station at Omo Rate:*** This is a facility from which management, monitoring, technical support and training would be coordinated.

ix. ***Training and Study Tour:*** Cost of training to strengthen EMU's capability in the area of environmental management and monitoring and international study tour to hydroelectric plant sites. In an effort to strengthen institutional capacity and environmental awareness, seminars, workshops and study tours to be organised under this project shall also be open for individuals from concerned ministries and agencies such as Federal MWR, EPA, SNNPR's office of Environmental protection, Regional Bureau of Agriculture and Rural Development, Regional and Wereda level Environment departments, etc. The objectives of the seminar-workshops are to ensure environmental awareness, knowledge and skill for the implementation of this ESMP.

x. ***Environmental Monitoring:*** To ensure that monitoring is adequately funded, costs to carryout a comprehensive environmental monitoring plan has been included. This will provide the basis for rational management decisions regarding impact control.

xi. ***Environmental Audit:*** The cost of systematic evaluation of the environmental and social performance of the project will be covered by the project.

9.2 Funding Mechanism

The total funding needed for identified activities is presented in Table 9.1. EEPCO is responsible for providing these resources from the national budget for all activities related to the implementation of environmental mitigation, management, monitoring and training programmes. Therefore, EEPCO is expected to set aside marginal benefits from the exploitation of the hydropower development for financing the long term financial needs of the social and environmental needs of the area such as environmental mitigation and management, social development projects, environmental monitoring, capacity building and training, etc.

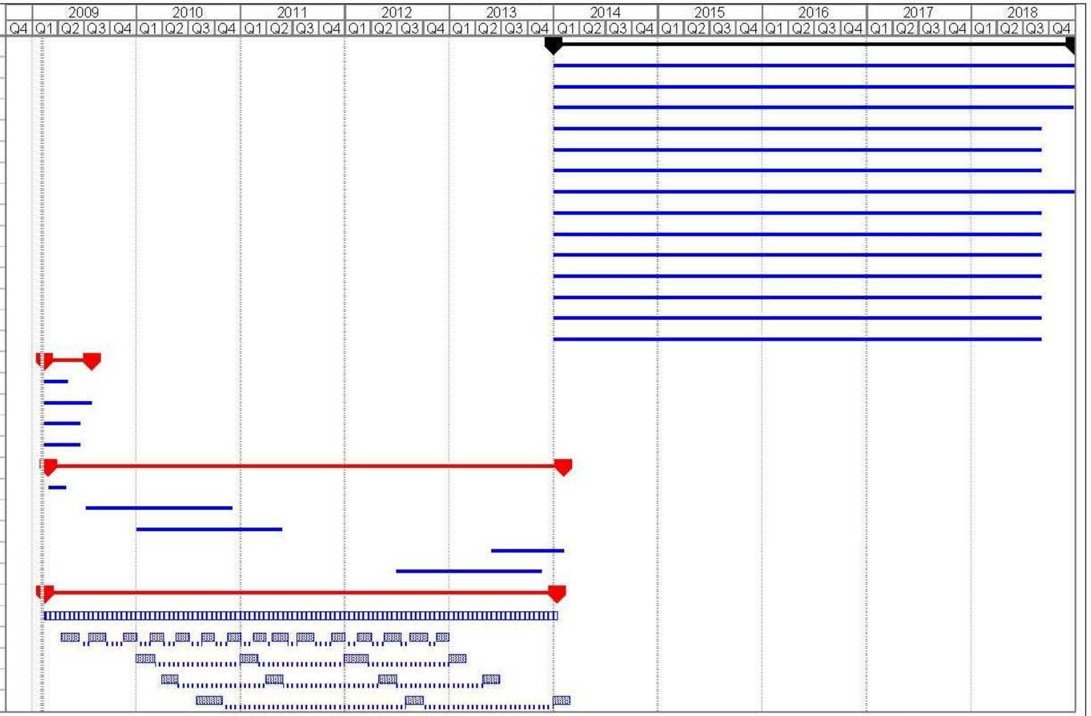
With this, EEPCO would demonstrate its commitment to its own environmental policy "to work towards realizing the objectives of sustainable development and continual improvements in its environmental performance". It will also decrease its short- and long-term liabilities and improve its public image by complying with existing national environmental regulations and ensuring that construction work does not adversely affect the environment and social community resources.

Table 9.1: Summary of Estimated Environmental Mitigation, Management, Monitoring and Training Costs

No.	Cost Items	Estimated Cost (birr)	Year											
			Construction phase						Operation phase					
			1	2	3	4	5	6	7	8	9	10	11	12
	Environmental Mitigation and Management Cost - Downstream Area													
1	Irrigated Agriculture													
1.1	Survey, design and tender document preparation	3,500,000					1,500	2,000						
1.2	Implementation of the irrigation schemes	32,000,000						8,000	8,000	8,000	8,000			
1.3	Capacity building and technical assistance	4,500,000							500	1,000	1,500	1,500		
2	Livestock production													
2.1	Livestock forage production on individual irrigated agriculture holding	4,000,000					500	500	500	500	500	500	500	500
2.2	Irrigated forage development - further in-land along the Omo River (Livestock Enterprises)	12,000,000					1,000	1,000	2,000	2,000	2,000	2,000	1,000	1,000
2.3	Range development and management in the Omo River Delta	6,000,000					1,000	1,000	1,000	1,000	1,000	1,000		
2.4	Improved livestock practices	8,000,000					1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
3	Fishery development	2,500,000					500	500	500	500	500			
4	Socio-economic support programme													
4.1	Livelihood economy diversification support programme	15,000,000						3,000	3,000	3,000	3,000	3,000		
4.2	Agriculture in service training for Farmers Training Centre (FTC)	4,500,000						1,500	1,500	1,500				
4.3	Wereda institution strengthening programme	12,000,000						6,000	6,000					
4.4	Facilitate the creation of cooperatives through capacity building and technical assistance	20,000,000						4,000	4,000	4,000	4,000	4,000		
4.5	Community awareness, regular information meetings and conflict prevention and resolution programme	8,550,000					550	1,500	2,000	2,000	1,500	1,000		
5	Install flow variation acoustic warning system (to inform about abrupt realse of waters to the downstream communities)	50,000,000						50,000						
6	Food aid during reservoir filling (for loss of recession agriculture)	60,000,000					30,000	30,000						
7	Establishment of Monitoring Station at Omo Rate	2,500,000				1,000	500	500	500					
	TOTAL	245,050,000	0	0	0	1,000	36,550	110,500	30,500	24,500	23,000	14,000	2,500	2,500
8	**ADMINISTRATION COST (5%)**	12,252,500												
9	**CONTINGENCY (10%)**	24,505,000												
	GRAND TOTAL	**281,807,500**	0	0	0	1,150	42,033	127,075	35,075	28,175	26,450	16,100	2,875	2,875

Figure 9.1: Implementation Schedule for Social Development Plans

ID	Task Name
45	**Environmental Monitoring (During Operation for 2 - 5 years)**
46	Hydrologic and climatic monitoring (continuous)
47	Sediment monitoring (continuous)
48	Watershed management
49	Buffer area development
50	Land use and land cover (Buffer area and lower Omo)
51	Public health (disease prevalence in and around reservoir area)
52	Water quality (reservoir and downstream)
53	Aquatic resources (reservoir and downstream)
54	Fishery resources (reservoir and downstream)
55	Wildlife resources (Buffer area)
56	Biodiversity assessment (Reservoir and Lower Omo)
57	Site restoration
58	Social development plan
59	Socio-economic monitoring (around the reservoir and downstream areas)
60	**Capacity Building and Procurement for EMU**
61	Develop capacity plan
62	Laboratory instrument and equipment
63	Field Vehicles
64	Office equipment and computers
65	**Training and Study Tour for EMU Staff**
66	Develop training plan
67	Conduct in-service training and technical assistance
68	Short-term overseas workshops, site visit and training
69	Agriculture extension team training (around reservoir area)
70	Awareness creation
71	**Annual Environmental Reporting and Review**
72	Monthly Environmental Inspection Report
73	Quarterly Environmental Monitoring Reports
74	Annual Environmental Report
75	Review Meetings by Environmental Advisory Panel
76	**Environmental audit**



10 CONCLUSIONS AND RECOMMENDATIONS

10.1 Conclusions

The Study main conclusions confirm that while overall flow regularization following project implementation will represent in general terms an overall long-term environmental and human stabilizing and developmental factor, the prevailing social settings and traditional cultural context as well as the present pattern of utilization of natural resources in the Lower Omo would not continue to take place unhindered to the current level and with the same (traditional) modalities if appropriate mitigation measures as planned are not deployed and secured on a permanent basis.

In the medium to long-term, the following main positive consequences may be expected from Gibe III Hydroelectric Project Development:

- A substantial degree of annual flow regulation in the Omo River, with avoidance of both disastrous floods and drought extremes and of their consequences on the physical, natural, and socio-economic environment;
- Stabilization of riverbanks, potential increase of overall biodiversity values of fluvial and delta natural environments, and reduction of waterlogging and water-borne diseases downstream impoundment;
- Indirect consequences (potentialities) in terms of enhanced rural development opportunities such as infrastructures and electrification, road and river transportation, settled irrigation agriculture, modern fisheries and tourism developments may also be expected, representing a unique opportunity to be seized for sustainable amelioration of local living conditions and poverty alleviation.

The foreseen mitigation actions are designed to allow human activities (recession agriculture, animal husbandry, and fisheries) to continue on the same scale as at present; a level which, at least in the case of agriculture, does not however guarantee self sufficiency in production.

In this regard the Project represents a real opportunity to sustainably develop agricultural technologies for both rainfed and irrigated cropping, thus aiming at achieving adequate productivity to meet local demand.

As it is considered that overall potentialities and benefits greatly outnumber prospective negative aspects, the Consultant concludes that there are no sufficient environmental grounds on which the Gibe III Hydroelectric Project should not be implemented as planned, thus substantially contributing to the sustainable development of the Lower Omo and the nation as a whole.

10.2 Recommendations

After analyzing the present social and environmental situation, and having quantified, with the limits deriving from its own scope, the extent to which Omo River fluctuations influence human activities and values and natural processes, the Consultant was able to provisionally propose and evaluate a number of planned actions the most important of which is represented by a specific annual river flow regulation regime.

Such regime is characterized by adequate (low) environmental flow, high (pulse) flow, and artificial floods whose yearly occurrence will permit to a great extent the continuation of existing downstream processes on the same levels of those normally taking place on an average year while at the same time providing security from recurrent extremes in terms of drought years and disastrous floods, both equally common in that unfortunate area.

It is however recommended that further baseline information and necessary data as identified are properly gathered by EEPCO in a five-year period in the course of the construction phase and beyond, during Project operation, in order of more precisely adjusting, through successive approximations, what actually proposed to actual needs, within a participatory course of action that will eventually empower local communities and contribute to bring about appropriate levels of rural development in the Lower Omo.

It is further recommended that, following Project implementation, a suitable proportion of Project revenues (provisional costs have been proposed) are utilized by GoE for environmental management and monitoring activities and for a number of compensation and development actions directed towards local populations, which are to be considered as Project shareholders and entitled to their well deserved share of development opportunities.

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Appendix 2: Visual Based Rapid Habitat Assessments

Appendix 2.1: Salamago

Visual based Rapid Habitat Assessment: Salamago

EPA Rapid Bioassessment Protocol (RBP)modified Barbour 1994

Station Location: Chainage 200-350 (Limited Flooded Area), Salamago Wereda, Ayloha Kebele, river crossing point to Omo National Park

Date and Weather Conditions: 6.12.07; Clear Sky

Predominant surrounding Land Use Type: Limited recession agriculture on riverbanks; riparian woodland;

Local Erosion: Moderate erosion on banks due to recession agriculture and unstable nature of soils

Riparian Vegetation (<18m>): Riparian vegetation often not reaching water level

Aquatic Vegetation: Aquatic plants scarce or absent

Turbidity: Heavy

Gradient: Moderate

Omo River at Ayloha River Crossing

1. Epifaunal Substrate / Available Cover

Habitat Parameter	Optimal	Condition Suboptimal	Cathegory Marginal	Poor
Epifaunal Substrate / Available Cover (high and low gradient)	Greater than 70% (50% for low gradient streams) of substrate favourable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	40-70% (30-50% for low gradient streams) mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of new fall, but not yet prepared for colonization (may rate at high end of scale).	20-40% (10-30% for low gradient streams) mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% (10% for low gradient streams) stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE 6	20 19 18 17 16	15 14 13 12 11	10 9 8 7 **6**	5 4 3 2 1 0

2.a. Embeddedness

Habitat Parameter	Optimal	Condition Suboptimal	Category Marginal	Poor
2.a Embeddedness (high gradient)	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
SCORE 4	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 **4** 3 2 1 0

3.a. Velocity / Depth Regimes

Habitat Parameter	Optimal	Condition Suboptimal	Cathegory Marginal	Poor
3.a Velocity / Depth Regimes (high gradient)	All 4 velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow).(slow is <0.3 m/s, deep is >0.5 m)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/ depth regime (usually slow-deep).
SCORE 9	20 19 18 17 16	15 14 13 12 11	10 **9** 8 7 6	5 4 3 2 1 0

4. Sediment Deposition

Habitat Parameter	Optimal	Condition Suboptimal	Category Marginal	Poor
4. Sediment Deposition (high and low gradient)	Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% (80% for low gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE 9	20 19 18 17 16	15 14 13 12 11	10 **9** 8 7 6	5 4 3 2 1 0

5. Channel Flow Status

Habitat Parameter	Optimal	Condition Suboptimal	Cathegory Marginal	Poor
5. Channel Flow Status (high and low gradient)	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE 12	20 19 18 17 16	15 14 13 **12** 11	10 9 8 7 6	5 4 3 2 1 0

6. Channel Alteration

Habitat Parameter	Optimal	Condition Suboptimal	Category Marginal	Poor
6. Channel Alteration (high and low gradient)	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reaches channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE 19	20 **19** 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

7.a. Frequency of Riffles (or bends)

Habitat Parameter	Optimal	Condition Suboptimal	Cathegory Marginal	Poor
7.a Frequency of Riffles (or bends) (high gradient)	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25.
SCORE 8	20 19 18 17 16	15 14 13 12 11	10 9 **8** 7 6	5 4 3 2 1 0

8. Bank Stability

Habitat Parameter	Optimal	Condition Suboptimal	Category Marginal	Poor
8. Bank Stability (score each bank) facing downstream (high and low gradient)	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30- 60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE 5 LB	10 9	8 7 6	**5** 4 3	2 1 0
SCORE 5 RB	10 9	8 7 6	**5** 4 3	2 1 0

9. Vegetative Protection

Habitat Parameter	Optimal	Condition Suboptimal	Category Marginal	Poor
9. Vegetative Protection (score each bank) facing downstream (high and low gradient)	More than 90% of the streambank surfaces and immediate riparian zones covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to row naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimetres or less in average stubble height.
SCORE 4 LB	10 9	8 7 6	5 **4** 3	2 1 0
SCORE 4 RB	10 9	8 7 6	5 **4** 3	2 1 0

10. Riparial Vegetative Zone Width

Habitat Parameter	Optimal	Condition Suboptimal	Cathegory Marginal	Poor
10. Riparian Vegetative zone width (score each bank) (high and low gradient)	Width of riparian zone >18 meters; human activities (i.e., Parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.
SCORE 3 LB	10 9	8 7 6	5 4 **3**	2 1 0
SCORE 3 RB	10 9	8 7 6	5 4 **3**	2 1 0

Appendix 2.2: Hamer

Visual based Rapid Habitat Assessment: Kara Korocho

EPA Rapid Bioassessment Protocol (RBP) modified Barbour 1994

Station Location: Chainage 350-660 (Moderate Flooded Area), Hamer Wereda, Karo Dis Kebele, Village of Kara Korocho.

Date and Weather Conditions: 09.12.07; Clear Sky

Predominant surrounding Land Use Type: Riverine woodland, bushland, limited recession agriculture on riverbanks

Local Erosion: Substantial erosion on banks due to unstable nature of soils, water level fluctuation, recession agriculture

Riparian Vegetation (<18m>): arboreal vegetation absent in most of riverbank

Aquatic Vegetation: Aquatic plants scarce or absent

Turbidity: Heavy

Gradient: Low

Omo River at Kara Korocho

1. Epifaunal Substrate / Available Cover

Habitat Parameter	Optimal	Condition Suboptimal	Category Marginal	Poor
Epifaunal Substrate / Available Cover (high and low gradient)	Greater than 70% (50% for low gradient streams) of substrate favourable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	40-70% (30-50% for low gradient streams) mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of new fall, but not yet prepared for colonization (may rate at high end of scale).	20-40% (10-30% for low gradient streams) mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% (10% for low gradient streams) stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE 3	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 **3** 2 1 0

2.b. Pool Substrate Characterisation

Habitat Parameter	Optimal	Condition Suboptimal	Category Marginal	Poor
2.b Pool Substrate Characterisation (low gradient)	Mixture of substrate materials, with gravel and firm sand prevalent; root mats and submerged vegetation common.	Mixture of soft sand, mud, or clay; mud may be dominant; some root mats and submerged vegetation present.	All mud or clay or sand bottom; little or no root mat; no submerged vegetation.	Hard-pan clay or bedrock; no root mat or submerged vegetation.
SCORE 8	20 19 18 17 16	15 14 13 12 11	10 9 **8** 7 6	5 4 3 2 1 0

3.b. Pool Variability

Habitat Parameter	Optimal	Condition Suboptimal	Category Marginal	Poor
3.b Pool Variability (low gradient)	Even mix of large shallow, large-deep, small shallow, small-deep pools present.	Majority of pools large deep; very few shallow.	Shallow pools much more prevalent than deep pools.	Majority of pools small shallow or pools absent.
SCORE 3	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 **3** 2 1 0

4. Sediment Deposition

Habitat Parameter	Optimal	Condition Suboptimal	Category Marginal	Poor
4. Sediment Deposition (high and low gradient)	Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% (80% for low gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE 13	20 19 18 17 16	15 14 **13** 12 11	10 9 8 7 6	5 4 3 2 1 0

5. Channel Flow Status

Habitat Parameter	Optimal	Condition Suboptimal	Cathegory Marginal	Poor
5. Channel Flow Status (high and low gradient)	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE 7	20 19 18 17 16	15 14 13 12 11	10 9 8 **7** 6	5 4 3 2 1 0

6. Channel Alteration

Habitat Parameter	Optimal	Condition Suboptimal	Category Marginal	Poor
6. Channel Alteration (high and low gradient)	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE 18	20 19 **18** 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

7.b. Channel Sinuosity

Habitat Parameter	Condition Category			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
7.b Channel Sinuosity (low gradient)	The bends in the stream increase the stream length 3 to 4 times longer than if it was in a straight line. (Note - channel braiding is considered normal in coastal plains and other low-lying areas. This parameter is not easily rated in these areas.)	The bends in the stream increase the stream length 2 to 3 times longer than if it was in a straight line.	The bends in the stream increase the stream length 1 to 2 times longer than if it was in a straight line.	Channel straight; waterway has been channelized for a long distance.
SCORE 7	20 19 18 17 16	15 14 13 12 11	10 9 8 **7** 6	5 4 3 2 1 0

8. Bank Stability

Habitat Parameter	Condition Category			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
8. Bank Stability (score each bank) facing downstream (high and low gradient)	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE 3 LB	10 9	8 7 6	5 4 **3**	2 1 0
SCORE 3 RB	10 9	8 7 6	5 4 **3**	2 1 0

9. Vegetative Protection

Habitat Parameter	Condition Category			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
9. Vegetative Protection (score each bank) facing downstream (high and low gradient)	More than 90% of the streambank surfaces and immediate riparian zones covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimetres or less in average stubble height.
SCORE 2 LB	10 9	8 7 6	5 4 3	**2** 1 0
SCORE 2 RB	10 9	8 7 6	5 4 3	**2** 1 0

10. Riparial Vegetative Zone Width

Habitat	Optimal	Condition	Cathegory	Poor
Parameter		**Suboptimal**	**Marginal**	
10. Riparian Vegetative zone width (score each bank) (high and low gradient)	Width of riparian zone >18 meters; human activities (i.e., Parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6meters: little or no riparian vegetation due to human activities.
SCORE 2 LB	10 9	8 7 6	5 4 3	**2** 1 0
SCORE 2 RB	10 9	8 7 6	5 4 3	**2** 1 0

Appendix 2.3: Omo River Delta

Visual based Rapid Habitat Assessment: Omo Delta
EPA Rapid Bioassessment Protocol (RBP) modified Barbour 1994

Station Location: Chainage 660-750 (Extensive Flooded Area), Omorate Wereda, Omo river lower delta, south of Toitella village.
Date and Weather Conditions: 11.12.07; Clear Sky
Predominant surrounding Land Use Type: grassland, marshland
Local Erosion: absent
Riparian Vegetation (<18m>): banks covered by grasses
Aquatic Vegetation: Aquatic plants scarce
Turbidity: limited
Gradient: Low

Omo River at Toitella Village

1. Epifaunal Substrate / Available Cover

Habitat	Optimal	Condition	Category	Poor
Parameter		**Suboptimal**	**Marginal**	
Epifaunal Substrate / Available Cover (high and low gradient)	Greater than 70% (50% for low gradient streams) of substrate favourable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	40-70% (30-50% for low gradient streams) mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of new fall, but not yet prepared for colonization (may rate at high end of scale).	20-40% (10-30% for low gradient streams) mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% (10% for low gradient streams) stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE 9	20 19 18 17 16	15 14 13 12 11	10 **9** 8 7 6	5 4 3 2 1 0

2.b Pool Substrate Characterisation

Habitat	Optimal	Condition	Category	Poor
Parameter		Suboptimal	Marginal	
2.b Pool Substrate Characterisation (low gradient)	Mixture of substrate materials, with gravel and firm sand prevalent; root mats and submerged vegetation common.	Mixture of soft sand, mud, or clay; mud may be dominant; some root mats and submerged vegetation present.	All mud or clay or sand bottom; little or no root mat; no submerged vegetation.	Hard-pan clay or bedrock; no root mat or submerged vegetation.
SCORE 14	20 19 18 17 16	15 **14** 13 12 11	10 9 8 7 6	5 4 3 2 1 0

3.b Pool Variability

Habitat	Optimal	Condition	Category	Poor
Parameter		Suboptimal	Marginal	
3.b Pool Variability (low gradient)	Even mix of large shallow, large-deep, small shallow, small-deep pools present.	Majority of pools large deep; very few shallow.	Shallow pools much more prevalent than deep pools.	Majority of pools small shallow or pools absent.
SCORE 19	20 **19** 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

4. Sediment Deposition

Habitat	Optimal	Condition	Category	Poor
Parameter		Suboptimal	Marginal	
4. Sediment Deposition (high and low gradient)	Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% (80% for low gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE 9	20 19 18 17 16	15 14 13 12 11	10 **9** 8 7 6	5 4 3 2 1 0

5. Channel Flow Status

Habitat	Optimal	Condition	Cathegory	Poor
Parameter		Suboptimal	Marginal	
5. Channel Flow Status (high and low gradient)	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE 20	**20** 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

6. Channel Alteration

Habitat Parameter	Optimal	Condition Suboptimal	Category Marginal	Poor
6. Channel Alteration (high and low gradient)	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reaches channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE 20	**20** 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

7.b Channel Sinuosity

Habitat Parameter	Optimal	Condition Suboptimal	Category Marginal	Poor
7.b Channel Sinuosity (low gradient)	The bends in the stream increase the stream length 3 to 4 times longer than if it was in a straight line. (Note - channel braiding is considered normal in coastal plains and other low-lying areas. This parameter is not easily rated in these areas.)	The bends in the stream increase the stream length 2 to 3 times longer than if it was in a straight line.	The bends in the stream increase the stream length 1 to 2 times longer than if it was in a straight line.	Channel straight; waterway has been channelized for a long distance.
SCORE 14	20 19 18 17 16	15 **14** 13 12 11	10 9 8 7 6	5 4 3 2 1 0

8. Bank Stability

Habitat Parameter	Optimal	Condition Suboptimal	Category Marginal	Poor
8. Bank Stability (score each bank) facing downstream (high and low gradient)	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30- 60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE 9 LB	10 **9**	8 7 6	5 4 3	2 1 0
SCORE 9 RB	10 **9**	8 7 6	5 4 3	2 1 0

9. Vegetative Protection

Habitat Parameter	Optimal	Condition Suboptimal	Category Marginal	Poor
9. Vegetative Protection (score each bank) facing downstream (high and low gradient)	More than 90% of the streambank surfaces and immediate riparian zones covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimetres or less in average stubble height.
SCORE 7 LB	10 9	8 **7** 6	5 4 3	2 1 0
SCORE 7 RB	10 9	8 **7** 6	5 4 3	2 1 0

10. Riparial Vegetative Zone Width

Habitat Parameter	Optimal	Condition Suboptimal	Cathegory Marginal	Poor
10. Riparian Vegetative zone width (score each bank) (high and low gradient)	Width of riparian zone >18 meters; human activities (i.e., Parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12- 18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6- 12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.
SCORE 8 LB	10 9	**8** 7 6	5 4 3	2 1 0
SCORE 8 RB	10 9	**8** 7 6	5 4 3	2 1 0

Appendix 3: Irrigated Agriculture – Mitigation Costs

Gibe III Project makes provision for physical mitigation measures to be implemented in case the envisaged annual release from the reservoir proves insufficient to fully reproduce the conditions in place at present for flood-recession agriculture to be continued without prejudice for the populations practicing this type of economic activity. In fact, under such circumstances, the project is expected to provide alternative sources of survival at least in terms of food crops i.e. grains (maize and sorghum).

It is envisaged that under such potential scenario the Project will proceed to assist the affected population by implementing small-scale irrigation schemes consisting of:

20-ha smallholder (0.25 ha) schemes: n° 100 schemes (2,000 ha) benefiting 8,000 families

3-ha irrigated individual schemes: n° 100 (300 ha) benefiting 100 commercial farmers

Most of these schemes will be located in Dasenech Wereda and to a lesser extent in Nyangatom Wereda, few of them in Salamago and Hamer Weredas, reflecting the actual incidence of the present flood-recession agriculture in the four project Weredas.

It is envisaged for this irrigation-development mitigation intervention to be studied in detail by a Technical Assistance team based in Omorate, Dasenech Wereda, which may integrate the technical staff fielded for the implementation of the works required to control the induced artificial flooding as described here above (flood-recession agriculture) in the present section.

The assumption made is that two years will be required for surveys, studies, construction drawings, cost estimates and tender documents preparation. The implementation phase will last 3 years, during which Wereda and Kebele officials, as well as beneficiary farmers will benefit from continuous capacity building and on-the-job training. Such assistance will start since the first year with training on project preparation and contract management, and will continue after implementation for one additional year, mainly on maintenance and irrigation management including financial aspects. The total duration for the envisaged measure to become fully operational will hence be 6 years.

Total cost for surveys, studies, project preparation, supervision, capacity building and training will amount to ETB 3.5 million. The envisaged disbursement will be ETB 1.5 million at the beginning of the first year and in the second year ETB 2.0 million.

The total cost will be ETB 32.0 million, disbursement can be assumed in ETB 8.0 million annualy, throughout the 4-year construction phase.

Appendix 4: Livestock Development Project Profiles

1. Livestock Forage Production on Individual Irrigated Agricultural Holding

Project Profile No.	
1. Title	Livestock forage Development on individual irrigated agricultural holding
2. Location	In Dasenech, Hamer, Nyangatom and Salamago Weredas where irrigated agriculture is practiced
3. Sector (s)	Livestock Production
4. Implementing Agencies	Region, community, individual
5. Project Documents	Gibe 3 Dam and Hydropower Plant. Environmental Impact Assessment. Additional Study on Downstream Impacts
6. Project Background	The main sources of livestock feed in the lower Omo basin are natural pastures. In areas where recession cultivation is practiced, livestock get additional feed in the form of crop residues. The availability of feed is dependant upon season and climatic condition. Generally, feed in lower Omo rangelands is short during the dry season. Situations get worse when rains get short and drought occurs. In such situations, pastoralists are forced to migrate to areas where forage is available. This in some cases requires prior arrangements are made to avoid clan conflicts. In other circumstances, they receive hostile receptions and there are cases of human and livestock losses. In areas along the Omo river there is the tradition of growing crops using irrigated water. A very few of these agro-pastoralists are observed growing small patches of forage along with the crops. Those individuals are able to supplement their livestock with green feed even during the dry season, when these types of feed are scarce. If properly planned this programme could be expanded on all individuals practicing irrigated agriculture along the Omo river. This could be coordinated with the irrigated agriculture as part of the proposed intervention.
8. Project Objectives	The main Project objective is supply additional feed for livestock any time of the year and especially during the dry season. Other objectives include: ▪ Improve the productivity and production of livestock ▪ Produce additional forage all the year round ▪ Supplement the feed requirement of the livestock with improved forage
9. Stakeholder Consultation	Region and Wereda administrations, farmers, technical staffs and livestock owners have been consulted on the resources, constraints, potentials and possible projects.
10. Project Description	The anticipated Project will have the following major components: ▪ Awareness Creation ▪ Training of agro-pastoralists and technical staff ▪ Provision of improved forage seeds and other materials ▪ Establishment of irrigated forage 0.5 to 1ha size In areas where irrigated agriculture in practiced, concerned individuals will be trained on the importance of producing forage as part of the irrigated programmes. To this effect the respective agricultural and rural development offices will establish demonstration plots along the Omo river. The respective agricultural and rural offices will be facilitated with the necessary materials and inputs to undertake irrigated forage production. These include farm tools, forage seeds and were necessary fertilizers and others. The inputs will also be available for the participation individuals. Trainings on irrigated agriculture will be arranged for the individuals participating in the programme. These include forge seedlings production, cultivation, care and feeding of forage to livestock. In-service training will also be organized for the technical staff. Participating individual's will allocate 0.5 to 1 ha of land for irrigate forage production. The required seed or seedlings and other impute will be provided as part of the package. It is required that the participation individuals manage the irrigated forage. These include cultivation, weeding, managing and later feed livestock when it ready, according to the recommendation.

Project Profile No.	
11. Main Beneficiaries	The main beneficiaries of the project include: agro-pastoralists, livestock owners and other individuals engaged in livestock activities. The livestock will also get continuous supply of forage all the year round.
12. Capital Costs	The project has a total cost of USD 471,222.2. The capital cost is USD 416,222.2 and the recurrent cost is estimated at USD 55,000.
13. Sources of Finance	Federal and Region governments, the community and individuals
14. Implementation Period	The anticipated project implementation period is 8 years, with the first two years as preparation and the remaining 6 years as actual project period
15. Environmental Impact	The project does not have any negative effect on the environment. Supply of supplementary feed to the livestock will reduce the pressure on the grazing land. This correspondingly reduces land degradation.
16. Risks and Uncertainties	Some of the anticipated risk and uncertainties include: ▪ Reluctant of individual to participate in the project ▪ Shortage of land to grow forage ▪ Shortage of supply of initial forage seeds and seedlings ▪ Subsequent supply of improved forage seeds and seedlings
17. Further Work Required	Some of the future work required include; ▪ Identification of participation individuals ▪ Identification of site for the establishment of forge seed and seeding, production ▪ Arrange for the supply of improved forage seeds ▪ Arrange programme for the distribution of seed and seedling

2. Irrigated Forage Development Further In-Land along the Omo River (Livestock Enterprise)

Project Profile No.	
1. Title	Irrigate forage development further in-land along the Omo river, with livestock enterprise
2. Location	The project will be implemented in Dasenech, Hamer, Nyangatom and Salamago Weredas of Lower Omo river. This would be part of the rangelands next to the irrigated cultivation along the Omo river.
3. Sector	Livestock Production
4. Implementing Agencies	Region, Agriculture and Rural Development Office of the respective Weredas, communities and individuals
5. Project Documents	Gibe 3 Dam and Hydropower Plant. Environmental Impact Assessment. Additional Study on Downstream Impacts
6. Project Background	The main sources of livestock feed in the respective Weredas of lower Omo river include natural pastures in the rangelands and crop residues. The former accounts for the highest proportion of livestock feed. In situations where recession agriculture is practices along the Omo river, though the quantity is small, crop residues are add ional sources. The grazing land is communally owned and is faced with “the tragedy of the commons”, where there is big competition between the individual interests trying to maximize for the open access rangelands. The availability of forage in the study area is dependant upon the season and the climate condition. Generally, feed is short during the dry season. Situations get worse, when there is disruption in the rainfall condition and even worst when drought occurs, which is a recurring phenomenon in lower Omo pastoral areas. Over grazing and livestock pressure on the rangelands is one of the main causes for the replacement of some the important forage species by undesirable species, resulting in the shortage of fodder for livestock. The major problems identified by the farmers in the study areas include low feed both in quality and quantity, early maturing of the forage and low awareness of the farmer on forage development. The shortages of improved forage seeds, seedlings and forage nurseries have exacerbated the situation. They have stressed that the productivity of the rangelands in the lower Omo is deteriorating so fast that after a few years it will simply be barn land unless something is done.

Project Profile No.	
7. Project Rationale	Forage in the lower Omo river is low both in quality and quantity. Feed is critically short in the months of December, January and February. In this situation, pastoralists migrate to areas where feed and water is available. This could be within or outside of the respective Kebeles or Weredas with their livestock. Undertaking development activities on the communal rangelands of the study area and establishment of the livestock enterprises like fattening will improve the forage condition; improve the productivity of the livestock thereby bringing about changes in the welfare of the farmer and livestock owners.
8. Project Objectives	The objective of the project is to increase the productivity of forage on common communal grazing land, on which the livestock depend upon. Other objectives include: ▪ Increase the overall production of fodder for livestock ▪ Improve the productivity and production of livestock in the project area ▪ Increase the vegetation cover of bare land, thus decreasing land degradation ▪ Involve in profitable livestock activities (fattening) ▪ Improve the livelihood of the poorest
10. Project Description	The project will have the following components: ▪ Create awareness ▪ Training on irrigated forage production ▪ Establishment of irrigate forage on units of 100ha ▪ Establishment of livestock enterprise (fattening) The project will be implemented on 1,000 ha irrigated forage per Wereda in the respective Weredas (Dasenech, Hamer, Nyangatom and Salamago). The pastoralists in the respective Weredas will be organized into groups on clan or Kebeles level to take care of 100 ha units. Each 100 ha unit will have common property rights and will be responsible for the development of the land through irrigated forage. The necessary inputs, farm tools, irrigation infrastructure and facilities will be covered by the project. Prior to the establishment of the project participation individuals or Kebeles will be trained on the different anticipated activities of the project. Utilization of forage produced from a communal land is in most cases difficult. This is because the livestock will destroy irrigation infrastructure if let in to graze on the forage. On the other hand, the output will not be sufficient for all livestock in the Kebeles. The realistic option is to establish common livestock enterprise (fattening) and use the forage for the livestock in the programme. . The respective Agricultural and Rural Development Offices will be responsible for the overall implementation of the project. Subject matte specialist will be assigned to supervise the project activities. Community Mobilization Specialists (CMSs) will be appointed by Kebeles and each will be responsible for about five units. The necessary awareness creation, training and provision of inputs will be arranged through the Agricultural and Rural Development Offices.
11. Main Beneficiaries	The main beneficiaries of the project are ▪ Livestock owners in the respective Weredas Dasenech, Hamer, Nyangatom and Salamago. ▪ Livestock traders through the supply of improved and healthy animals for local as well as export markets ▪ Individuals employed in the irrigation and livestock enterprises
12. Costs	The estimated project cost is USD 1,167,000. The investment and recurrent costs are estimated to be USD 1,017,000 and 150,000, respectively.
13. Sources Of Finance	Federal and Region governments, the community and individuals
14. Implementation Period	It is anticipated that the whole project will be implemented in eight years period. The first two years are considered as project preparation periods.
15. Environmental Impact	There is no detrimental effect on the environment. Improvement of rangeland and use it into production through irrigated forage production will increase vegetation cover and reduce rangeland degradation.
16. Risks and Uncertainties	The Risks and uncertainties anticipated include:- ▪ Short supply initial forage seeds

Project Profile No.	
	▪ Reluctant of community to allocate common grazing land for the anticipated irrigated forage development ▪ Delay on the part of the participants to capture routine irrigated forage development activities ▪ Delay in getting market outlet for the finished animals
17. Future Work Required	▪ Identify suitable land for the project ▪ Formation of Community Mobilization Specialists ▪ Assignment of subject matter specialists ▪ Setting up management committee for the anticipated livestock enterprises in the respective 100 ha units ▪ Look for possible outlets for the finished animals from the enterprise

3. Range Developments and Management in the Omo River Delta

Project Profile No.	
1. Title	Range Development and Management in the Delta, Dasenech Wereda
2. Location	The project will be implemented in Dasenech Wereda of Lower Omo river. This will be in the possible 31 or so islands in the outlet of the Omo river
3. Sector	Livestock Production
4. Implementing Agencies	Region, Agriculture and Rural Development Office of the Dasenech Wereda, communities and individuals
5. Project Documents	Gibe 3 Dam and Hydropower Plant. Environmental Impact Assessment. Additional Study on Downstream Impacts
6. Project Background	The Omo Delta is located at the lowest bottom of the Omo river, just before it enters lake Turkana. It is composed of a series of 31 islands. The delta is inundated with water part of the year, when the Omo river overflows it banks. So they are of use only the rest of the year. Livestock go to the different islands by swimming across the Omo river. For the rejuvenation of the grass and vegetation, the flooding of the islands is necessary. It has been reported that when the water level of the Omo river is low and part of the islands upstream are not covered with water the vegetation cover is reduced and sometimes lost. So, they claim that the complete inundation is important. Officials, technical staff, individuals and pastoralist claim that the survival of the livestock in Dasenech and the adjacent Weredas is dependent upon the vegetation in the delta. Once the islands are open for livestock, there is no restriction to the number of animals grazing on it. There is no also controlled grazing and livestock are everywhere all the time. The vegetation is mismanaged and as a result most of the biomass is lost through trampling, which could have sustained even more animals. To give chance for the vegetation in the delta to grow better, produce more biomass and maintain more livestock, proper management and utilization intervention in this respect is necessary. These include dividing the islands into different natural paddocks, conserving part of the biomass for later use (when the area is inundated with water or when there is feed shortage) and improving the grass/legume mix.
7. Project Objectives	The main objection of the project is to properly manage and utilize the naturally occurring natural vegetation in different island of the Omo delta. Other objectives include: ▪ Bring about improvement in the biomass production of the vegetation in the Omo delta ▪ Improve the condition of livestock ▪ Increase the off take, productivity and production of livestock in the Wereda ▪ Increase the income that pastoralists could get out of the livestock
7. Stakeholder Consultation	Pastoralists, technical staff, officials and other informants at the region, zone, Wereda and Kebeles level have been consulted on the resource, management, utilization and abuse of the biomass in the delta. Possible interventions have also been raised and

Project Profile No.	
	discussed.
9. Project Description	The different components of the project include: ▪ Sustain the inundation of the islands part of the year ▪ Proper management of the biomass in the delta ▪ Training of livestock owners and technical staff The inundation of the islands in the Omo delta part of the year is important. Currently, the biomass in the Omo delta is not properly managed. To this effect, different improvement measures, which include paddocking of the islands, conservation of forage, rotational grazing, etc will be devised. These will be prepared and implemented with the consultation of the concerned stakeholders, which include: clan leaders, pastoralists, Wereda officials, Wereda agricultural technical staffs and others involved in livestock development. Conducting orientation and training of livestock owners and technical staff is part of the intervention. This will create awareness and proper implementation of the different components.
10. Main Beneficiaries	The main beneficiaries of the project include: pastoralist, livestock traders and others involved in livestock development.
11. Projects Costs	The total cost of the project is estimated to be USD 568,000. The capital and running costs are calculated to be USD 564,000 and 4,000, respectively.
12. Sources of Finance	Federal and Region governments, the community and individuals
13. Implementation Period	The implementation period of the project is six years.
14. Environmental Impact	No negative environmental effect is expected in the implementation of the project. On the other hand, the proper range management and utilization will bring about good vegetation cover of the ground, thus reducing overgrazing and land degradation
15. Risks and Uncertainties	Some of the anticipated risk and uncertainties include: ▪ Time lag due to remoteness of the area ▪ The interventions are new concepts and creating awareness may take some times ▪ Construction of devise along the Omo river to simulation flood may take time
16. Further Work Required	Further work required include: ▪ Determining the size of the different islands in the delta ▪ Allocation of paddocks for the livestock according to number ▪ Conduct a series of consultation programmes with clan leaders pastoralists on the implementation of the different components of the project

4. Improved Livestock Practices

Project Profile No.	
1. Title	Improved Livestock Practices
2. Location	The project will be implemented in Dasenech, Hamer, Nyangatom and Salamago Weredas of Lower Omo river.
3. Sector	Livestock Production
4. Implementing Agencies	Region, Agriculture and Rural Development Office of the respective Weredas, communities and individuals
5. Project Documents	Gibe 3 Dam and Hydropower Plant. Environmental Impact Assessment. Additional Study on Downstream Impacts

Project Profile No.	
6. Project Background	The lower Omo project area consists of Dasenech, Hamer, Nyangatom and Salamago Weredas in southern Omo zone. The livestock in the study area are indigenous types comprising of cattle, sheep, goats, equines, poultry and bees. They are kept for the subsistence of the farmer and his family, which provide him with food, cash income (limited level), and as bank in the in the accumulation of wealth. Feed of livestock are obtained mainly from natural pastures followed by crop residues. The later is practiced in areas where recession agriculture is underway. Various types of livestock diseases occur in the watershed affecting all species of livestock and are severe during the wet season. The veterinary service available is limited and serves only few in and around major Wereda towns and where animal health posts are established. Livestock in the watershed have low productivity capacity. This is associated with various types of livestock diseases affecting all species, low fodder productivity and production, low genetic potential of the livestock breeds, poor animal health service, low livestock extension coverage, few water points and etc. The Agricultural and Rural Development Office give animal health services through vaccination and treatment. Currently, the respective Wereda, Agricultural and Rural Development Offices are conducting weak livestock development activities. To effectively utilize the livestock resources of the study area and alleviate poverty, improvement in the various livestock practices is important.
7. Project Rationale	The livestock in the watershed are large in number, which do not commensurate with the benefits obtained. Various problems including feed, health, water, poor management and disorganized markets contribute to the low productivity of livestock in lower Omo Weredas. To increase the productivity and production of livestock, improve the contribution of livestock to the livestock owner in particular and the watershed and nation in general through proper use of the natural resources and available facilities calls for the development of appropriate interventions. To this effect, various development activities designed to improve livestock practices is proposed.
8. Project Objectives	The main objectives of the project include: ▪ Improve the productivity and production of livestock in the project area ▪ Overcome the problem of shortage of animal health infrastructure and facilities ▪ Reduce the incidence and effect of animal disease ▪ increase the off-take rate ▪ Increase the production and availability of fodder ▪ Reduce problem associated with weak livestock extension services
9. Stakeholders Consultation	Pastoralists, technical staff, officials and other informants at the region, zone, Wereda and Kebeles level have been consulted on the livestock resources, management and possible interventions.
10. Project Description	The project will have the following main component:- ▪ Establishment of Animal Health Posts ▪ Facilitate clinics(old) and Animal Health Posts (new and old) with the essential veterinary equipment and medicaments ▪ Improve the local livestock breed through introduction of improved local lowland breed (Borena) ▪ Provision of additional watering points ▪ Strengthening of livestock extension services Animals Health Posts will be established at Kebeles level, each to serve not more than three to five Kebeles. Animal Health Technician or community based animal health worker will be assigned to run the centre. Initially, each centre will be furnished with the necessary equipment drugs. Thereafter, it is run on a revolving fund system through income from the sales of drugs. Similarly, there will be provision to supply old Animal Health Posts and government clinics with essential drugs and medicaments. In addition, also the government clinics will be

Project Profile No.	
	supplied with veterinary equipment. To improve the supply of water to livestock as well as human, ponds and where appropriate shallow and/or deep wells will be developed in the project area. The water sources are constructed in such a way that they will be used only part of the year. If livestock are let to stay longer than necessary of settle permanently around, they will not only disturb the re-growth of vegetation, but also destroy the eco-system. The pastoralist are not also in favour of permanent water supplies The livestock in the project area are of indigenous types, where no selection of cross breeding has taken place. They have stayed in the area for centuries and have adapted to the harsh environmental conditions. They have the capacity to withstand high livestock disease incidence, low feed and water supply, and hot environmental conditions. Adulteration with highland breeds and in-breeding are common phenomenon. In this programme, local but improved breeds will be introduced for cross breeding purposes. One possible breed is Borena and the other is Sheka (trypanotolerant breed). Individuals or group of pastoralist will be advised to maintain these imported local breeds to breed their heifers and cows as well as animals of interested individuals. Orientation to the farmers and in-service training to the technical staff is the other component of the project. Selected individuals will also be trained on basic animal health and reporting of disease outbreaks. These types of individuals, commonly known as Community Based Animal Health Workers will serve the pastoralist at community level. The extension service will be strengthened through provision of transport to the development agents (bicycle or mule), upgrading the DA office, etc. provision of visual aids and other teaching material is part of the project. Because of the intervention, the anticipate changes include improvement in the extension and livestock health services, decrease in the rate of mortality and morbidity, increase in productivity of the individual animal and increase in the off-take.
11. Main Beneficiaries	The main beneficiaries of the project include: ▪ Pastoralist and all livestock owners in Dasenech, Hamer, Nyangatom and Salamago Weredas ▪ Livestock traders through the supply of improved and healthy animals for local as well as export markets At the end, a total of 8,000 livestock owners will benefit because of the interventions.
12. Costs	The total cost of the project is estimated to be USD 862,000. The capital and running costs are calculated to be USD 740,000 and 122,000 respectively.
13. Source of finance	Federal and Region governments, the community and individuals
14. Implementation	The implementation period of the project in eight yeas. The firsts two years are considered as preparation period.
15. Environmental Impact	There is no detrimental effect on the environment. The only drawback is possible spread of livestock disease as a number of animals come to the different health post and clinics. The other possible problem is accumulation of large numbers of livestock in and around watering points.
16. Risks and Uncertainties	The Risks and uncertainties anticipated include:- ▪ Dissemination of livestock disease ▪ Reluctant of individual to participating in the project ▪ Unwillingness of pastoralist in using imported improved local breeds
17. Further Works	▪ Identify strategic sites for the establishment of Animal Health Posts ▪ Identify and train individuals from the community to work as Community Based Animal Health Worker ▪ Assignment of Animal Health Technicians and or Community Based Animal Health workers at animal health post sites ▪ Identification of sites for the development of livestock watering points ▪ Arrange pastoralists trainings and in-services training for the technical staff

Appendix 5: Summary of Fishery Support activities costs

	Description of item/activity	Unit cost	unit	Total cost Br	Remark
	Survey, sampling and training boat	50000	1	50000	For Omorate main centre
	Outboard engine	50000	1	50000	
	Survey, sampling and training boat	50000	2	100000	For sub-stations/reservoir
	Out board engine	50000	2	100000	
	Fish sampling and demonstration gear	150,000		150,000	Nets, lines, hooks, length and wt measuring, dissection tools, etc.
	Water/plankton sampling equipments	150,000		150,000	Water bottles, plankton nets, water chem. kits, grabs etc
	Lab. equipments and furniture	200,000		200,000	Reagents, glassware, freezer, etc. for the Omorate Centre
	Skilled personnel @3500 month^{-1}	42000	2	84000	For 1 year
	Technical assistants @1500 month^{-1}	18000	2	36000	Also serve as trainers for fishers
	DA data collectors at sub-stations	10000	6	60000	Including at the reservoir fishery
	Vehicle for field work	500000	1	500000	4WD
	Fuel lubrication and maintenance	50000		50000	For 1 year
	Fuel and maintenance – boat engines	100000		100000	For three engines one year
	DSA for field workers	120000		120000	For all stations
	Technical training for fishers	100000		100000	For all stations
	Infrastructure development	200000	2	400000	fish store, processing shed, fish shops…etc - Omorate and Reservoir
	Initiate fish culture activities	200000		200000	
	Market promotion for fish products	50000		50000	
	Sub Total			**2,500,000**	
	Initial minimum credit requirement for the Fishery Cooperatives	2,000,000		2,000,000	For cooling and transport facilities under the extension program
	Sub Total			**2,000,000**	
	Grand Total			**4,500,000**	

Appendix 6: Recommended Socio-Economic Development Projects

1. Livelihood economy diversification, training and support program.	
Duration	5 years
Implementing agency	Regional and Wereda Level Agricultural and Rural Development Offices + Pastoralist Area Development Coordination Commission + partnership with local NGOs
Estimated cost (Birr)	15,000,000

2. Agriculture in service training program for Farmers Training Centre (FTC) personnel.	
Duration	3 years
Implementing agency	Regional and Wereda Level Agricultural and Rural Development Offices + partnership with Ethiopian University
Estimated cost (Birr)	4,500,000

3. Wereda institutions strengthening programme	
Duration	5 years
Implementing agency	Regional and Wereda Level Agricultural and Rural Development Offices + EMU + NGOs
Estimated cost (Birr)	14,000,000

4. Facilitate cooperative creation through specific capacity building and technical assistance program.	
Duration	5 years
Implementing agency	Regional and Wereda Level Agricultural and Rural Development Offices + Omo Microfinance institute + partnership with NGOs
Estimated cost (Birr)	20,000,000

5. Community awareness and regular information meetings between project management and officials from project affected Weredas to share information on water management program in the 4 affected Weredas	
Duration	5 years
Implementing agency	EMU / sub-contracted to local NGOs
Estimated cost (Birr)	2,500,000

6. Conflict prevention and resolution programs for Wereda and Kebele officials	
Duration	5 years
Implementing agency	Regional Offices + Wereda Offices + NGOs
Estimated cost (Birr)	5,000,000

7. Elaboration of an efficient information system for the project area inhabitants concerning possible short environmental changes and feasible production alternative support.	
Duration	5 years
Implementing agency	EMU + Sub-contracted to local NGOs
Estimated cost (Birr)	2,500,000

8.Coordination measures for food aid	
Duration	3 years
Implementing agency	Regional and Wereda Level Agricultural and Rural Development Offices + EMU + Food Security and Emergency Preparedness Department
Estimated cost (Birr)	60,000,000

Appendix 7: Total Suspended Solids - Sampling Campaign

1 - General

In the months of February, March and April 2008, a campaign of sampling collection for Total Suspended Solids was carried out. At the beginning of April the whole set of TSS analysis performed was integrated with chemical analysis on nutrients and oxygen demand.

Some hot spots have been selected in order to have a realistic image of the distribution of the fine sediment floating in the water courses and the basic mechanism of transportation for particles and nutrients.

Several samplings have been performed care of the temporary bridge currently in use at Gibe III.

In the aim to foresee the behaviour of the system River-Dam at Gibe III dam site, a similar model scale 1:1 already working in the regional area has been chosen for assessment and sampling. The sampling program is based on samples collected in Gibe I dam system where a 25 meters dam stops the course of Gibe River and the associated transported sediments.

2 - Sampling date and locations

Omo River temporary bridge

In order to assess the ordinary TSS transport condition In the Omo River, a sampling location has been selected. The section on the river is located at the temporary bridge, out of the trachytic narrow of Gibe III dam site.

The temporary bridge is made with a series of six culverts with internal diameter ranging between 4 and 5.4 meters.

The samplings have been carried out on:

- 4th February 2008,
- 13th February 2008,
- 14th February 2008,
- 15th February 2008,
- 16th February 2008,
- 17th February 2008,
- 18th February 2008,
- 20th February 2008,

For the whole set of samplings the related speed was recorded.

A more recent sampling set was performed at the temporary bridge on:

- 3rd April 2008,

in order to have a reference measure at the same time of the Gibe I-Gibe II system water sampling.

Gibe I - Gibe II System

Gibe I dam is a 25 meters weir built on the Gibe river. In order to have the exact perception of the total suspended solid stopped from this weir and the possible changing of the nutrients amount induced, successive samplings have been performed along the river.

The analysis on the system has been performed collecting samples in the river course upstream the dam, inside the reservoir and downstream.

The locations selected for sampling and included in the system model are:

- Asendabo bridge, considered as the upstream spot of the system;
- Gibe I reservoir, considered as the basin where the sediments could deposit and the nutrients develop;
- Gibe II intake, considered as the downstream spot of the system.

In figure 2.1 the sketch of the system is shown.

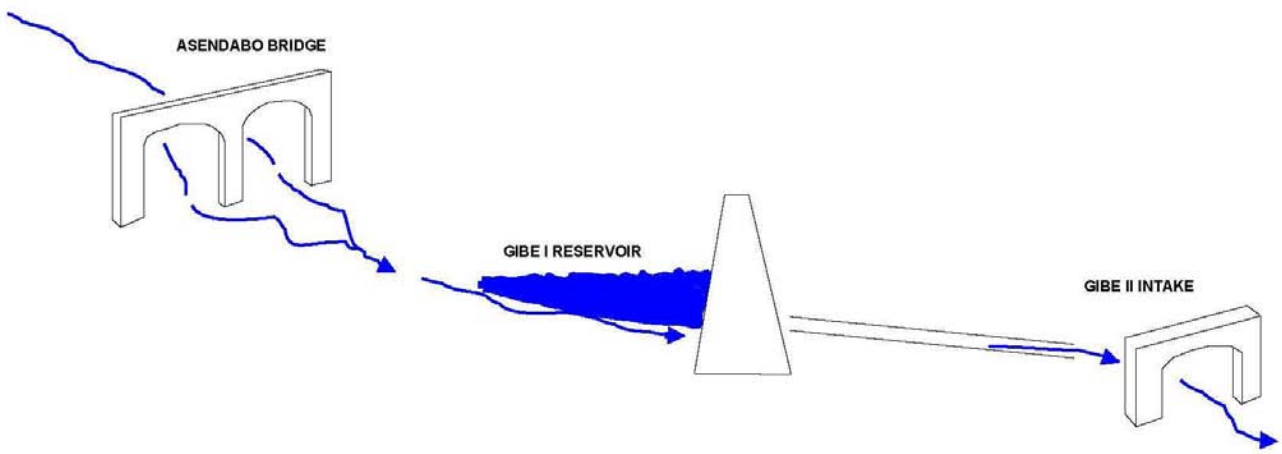

Figure 2.1: Gibe I-Gibe II system sketch

At the same time, in order to record the sediment and the basic water quality patterns, a set of water samples have been collected in the Omo river.

The analysis of the TSS has been performed at Gibe 3 laboratory SP1 while the chemical and biological analysis care of the Water Technology Institute of the Environmental Engineering Department at Arba Minch University

3 - The Total Suspended Solids

Total Suspended Solids refer to matter suspended or may affect water or environment in a number of ways and solids analyses are important in the control of biological and physical processes.

‘‘Total solids’’ is the term applied to the material residue left in the vessel after evaporation of a sample and its subsequent drying in an oven at a defined temperature. Total solids includes ‘‘total suspended solids,’’ the portion of total solids retained by a filter, and ‘‘total dissolved solids,’’ the portion that passes through the filter.

The type of filter holder, the pore size, porosity, area, and thickness of the filter and the physical nature, particle size, and amount of material deposited on the filter are the principal factors affecting separation of suspended from dissolved solids.

‘‘Dissolved solids’’ is the portion of solids that passes through a filter of 2.0 µm (or smaller) nominal pore size under specified conditions. ‘‘Suspended solids’’ is the portion retained on the filter. ‘‘Fixed solids’’ is the term applied to the residue of total, suspended, or dissolved solids after heating to dryness for a specified time at a specified temperature.

4 - Method

In the filtration method, the water sample is passed through a pre-weighed paper filter. The filter contained the sediments is then oven-dried, cooled in a desiccators, and weighed. Sediment weight is computed as the final less the original (tare) weight. Filtration has the advantage of eliminating the need to compensate for dissolved solids in the water, and it can also be more rapid that the evaporation method. The filters can become clogged if more than several hundred milligrams for liter of fines or abundance of organic substance is present. In this case a new filter paper has to be prepared and used.

A well-mixed sample is filtered through a weighed standard paper filter and the residue retained on the filter is dried to a constant weight at 103 to 105°C. The increase in weight of the filter represents the total suspended solids.

mg total suspended solids/L = ((A-B) x 1000) / sample volume (ml)

where:

> A = weight of filter + dried residue, mg, and
> B = weight of filter, mg.

This method is one of the recognized standard methods used in the sub-sample preparation referring to the EPA’s TSS (total suspended solids) Method (USEPA 1999) stirs and collects the sub-sample by pouring from the whole sample container.

Before the analysis performed as soon as possible since the collection, the samples have been refrigerated at 4°C up to minimize microbiological decomposition of solids. The samples have been brought to room temperature before analysis.

The equipment selected for the whole analysis is listed below.

- Graduate cylinders
- Top-loading analytical balance
    - 200 mg capacity
    - 0.001 mg resolution
    - calibration weights
- Drying oven
- 95 grade filters (1.5 µm pore-size) Whatman 542 and 50

Photo 4.1: Basic equipment for TSS analysis.

5 - Suspended Solids Size

The collected suspended solids consist of the sediment found on the streambed that is transported by water, especially during high flows. Not all the fine material found in streambeds are considered movable, such the deposits of cohesive clay.

As shown in fig. 3.1, the suspended load is the one to be collected during this sampling campaign. Because of the high water speed, this refers to the material moving in suspension in the first meter below the water level and sustained in the water column by turbulence or in colloidal suspension.

At the contrary the bed material consists of the grain size which is predominantly represented in the movable bed of a stream, below the sampling line.

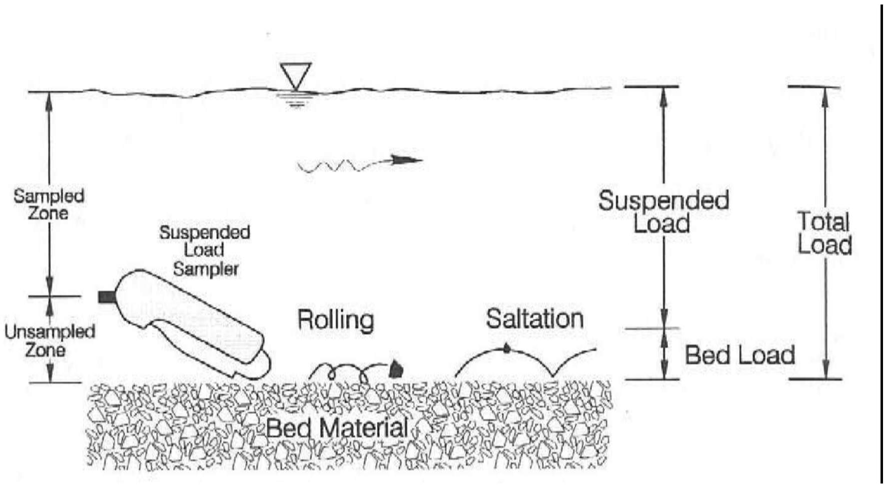

Figure 5.1: sketch of the particle transportation at different water level

The analyzed material had its particle size presumably ranging from 10 to 50 microns (January – February water flow). In this preliminary phase of the study a detailed grading of the material is considered unnecessary.

The particle filtration was performed using Whatman filter with the following manufacture characteristics:

- Brand:	Ahlstrom
- Catalog:	0950 - 1500
- Grade:	95
- Retention in µm:	1.5
- Filtration speed (Herzberg sec/100ml):	491
- Filtration speed (Rapidity ml/min):	14
- Loading capacity:	Medium
- Whatman Cross Reference:	542 and 50

Ahlstrom filters are supported through registered adherence to ISO 9001 standards.

6 - Suspended Solids and Nutrients

Manipulation of water levels and sediments will potentially impact phosphorus levels and productivity in the reservoir and downstream ecosystems, so the continuous campaign of sampling in the Omo river and the related TSS analysis are oriented in this way.

It is widely recognized that phosphorus and nitrogen are the primary nutrients in most of the reservoirs. Of these, phosphorus is the least abundant of the major nutritional and structural components of biota, and it is removed from aquatic systems rather rapidly and becomes stored in sediments, where its concentration may be 2 orders of magnitude greater than the concentration in the overlying water.

Phosphorus

Most phosphorus in natural aquatic environments is contained in particulate form, primarily in seston, which is both the living and non living organic particulate matter suspended in water. The dissolved phosphorus fraction consists of the material passing a 0.5 µm filter and includes dissolved inorganic orthophosphate ($P0_4^{-3}$)**,** the only inorganic form available for uptake by algae, and organic phosphate in a colloidal state.

The particulate fraction includes phosphorus contained in or adsorbed onto seston and/or inorganic complexes such as clays and others.

While most phosphorus in natural lakes is associated with seston, in reservoirs experiencing significant sediment loads much phosphorus may be associated with sediment, primarily the fine fraction that has a large surface area in relation to mass. The total concentration and fractionation of phosphorus will vary seasonally.

The dissolved phosphorus is no longer trapped over a period of several months and can migrate into the water column from a depth of at least 0.1 m within eutrophic mud. The rate of phosphorus release can be further accelerated (e.g., doubled) by agitation from turbulence.

Because of the longitudinal gradients characteristic of reservoirs, the significance of internal nutrient cycling can vary from one location to another. These dynamics may be summarized by stating that surface discharge reservoirs tend to trap nutrients and export heat, whereas reservoirs with deep discharges tend to export nutrients and trap heat (Wright, 1967).

Nitrogen

Elemental nitrogen (N_2), the most abundant form of nitrogen in aquatic systems, is biologically non-reactive except for nitrogen-fixing organism. Nitrate (NO_3^-) is commonly the predominant form of reactive nitrogen in aquatic system. Other forms as ammonia (NH_4^+) and Nitrite (NO_2^-) are present.

Unlike phosphorus, nitrogen is very mobile and is not highly absorbed by soil, and only ammonia (NH_4+) tends to be adsorbed by clay or organic particles.

The nitrogen cycle is complex, and nitrogen may exist simultaneously in many forms in the water column. Nitrogen transformations are controlled largely by microbes. The rate of nitrogen exchange between sediment and the water column varies greatly as a function of various factors.

7 - Omo River: Temporary bridge sampling station

7.1 - February 2008 sampling campaign

The water samples have been collected by means apposite customized sampler built for collecting samples at different depth when it is possible. The section of the temporary bridge is quite regular with six parallel culverts, two with 4.0m and four with 5.40m diameter, extended for an approximate length of 35m (photo 7.1-2).

According with the sampling positions and nearly 10 cm below the water surface, flow speeds were recorded.

Photo 7.1: The temporary bridge from upstream.

Photo 7.2: Water speed recording at the temporary bridge

The samples collected at the temporary bridge located downstream the dam site narrow are following described.

Daily TSS data were inserted in apposite forms shown in figure 7.1 where the content is associated with related parameters such as depth and punctual speed.

salini COSTRUTTORI s.p.a / SP studio ing. g. pietrangeli s.r.l. consulting engineers , Rome-ITALY			
	BENEFICIARY:	EEPCO	GIBE III, INVESTIGATION, LAB TEST
	CONTRACTOR:	Salini Costruttori s. p. a.	TOTAL SUSPENDED SOLIDS
	DESIGNER:	studio ing. g. pietrangeli	

		Sampling Coordinates			Section Coordinates	
		East	North		East	North
Sampling Date:	04 February 2008					
Testing Date:	05 February 2008					
Location:	Temporary bridge	-	-	Right Bank	310674	755488
				Left Bank	310707	755463

N.	Date (1)	Time (2)	Sample (3)	Chainage (4)	Depth Sp(5)	Speed (6)	Depth Sa(7)	TSS (8)
	dd/mm/yy	hh:mm	ID	m from RB	m	m/sec	m	mg/l
1					0.0	1.729		-
2	04/02/2008	16.15	R1	3.0	0.2	2.056	0.5	181
3					0.0	1.905		-
4	04/02/2008	16.18	R2	8.0	0.2	1.742	0.5	173
5					0.0	2.131		-
6	04/02/2008	16.22	R3	12.5	0.2	2.106	0.5	-
7					0.0	2.219		-
8	04/02/2008	16.25	R4	18.5	0.2	2.270	0.5	138
9					0.0	2.257		-
10	04/02/2008	16.30	R5	25.0	0.2	2.182	0.5	-
11					0.0	3.693		-
12	04/02/2008	16.40	R6	31.5	0.2	3.809	0.5	162
							AVG (mg/l):	164

Remarks:
(1) Measurement date
(2) Measurement time
(3) Field sample code
(4) Chainage from the right bank
(5) Speed measure depth
(6) Punctual water speed
(7) Sampling depth
(8) TSS content retained at 95 grade filter paper

Figure 7.1: TSS form with detailed speed and depth measures.

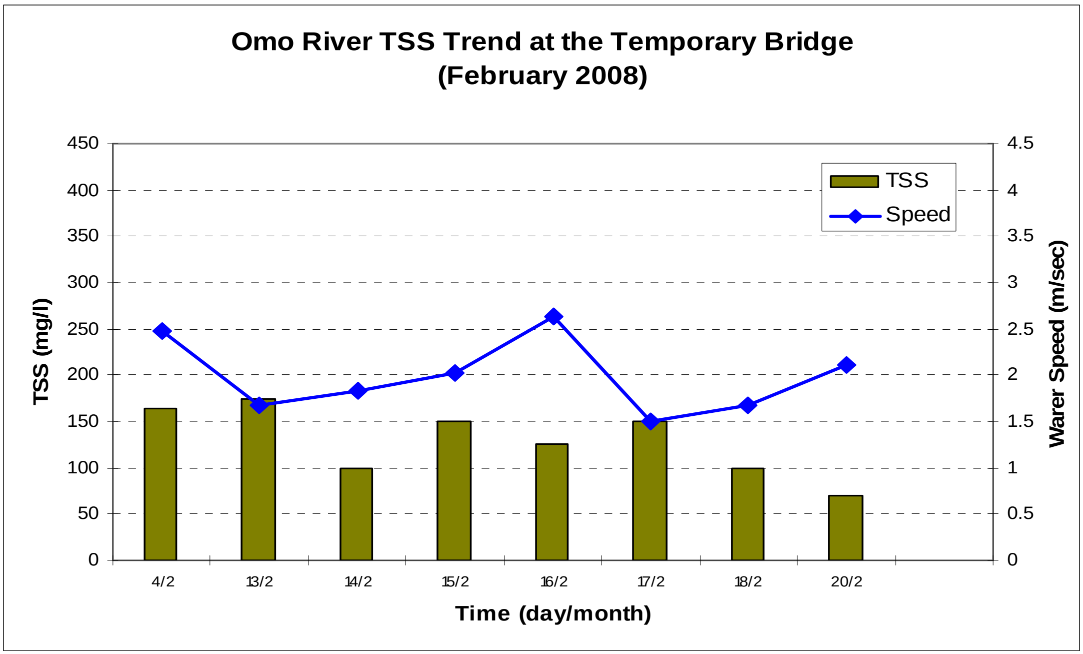

Figure 7.2: **Total Suspended Solid / Speed trend in the Omo river flow at temporary bridge.**

Here the water speed is definitely higher and a special sampler has to be used to sink below the water surface. The average punctual flow shows values around 2 m/sec with top speed over 2.5 m/sec.

The trend of Total Suspended Solids content indicates a general low value characterizing the whole dry season. The average value is around 130 mg/l more or less influenced by unsteady conditions of river water transport because of the upstream works (quarrying, tunnel material disposal).

Detailed spreadsheets with sampling depths and speed measures are available at SP site.

Recently the measures have been intensified. N.15 samples have been collected and related when possible with water speed measures.

A sketch of the sampling locations has prepared and shown in figure 7.3

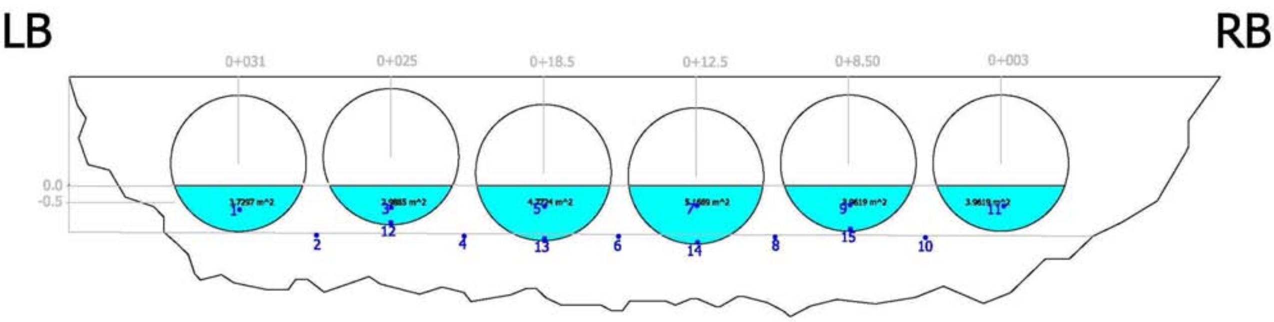

Figure 7.3: **Sampling locations at the temporary bridge**

The spreadsheet with the values collected is reported in figure 7.4.

The total suspended solids are quite homogeneous in weight with average value of 138 mg/l and extremes ranging between 80 and 197 mg/l. The speed ranges between 0.8 and 1.8 m/sec.

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	BENEFICIARY:	EEPCO	GIBE III, INVESTIGATION, LAB TEST
	CONTRACTOR:	Salini Costruttori s. p. a.	TOTAL SUSPENDED SOLIDS
	DESIGNER:	studio ing. g. pietrangeli	

		Sampling Coordinates			Section Coordinates	
Sampling Date:	28 March 2008					
Testing Date:	30 March 2008	East	North		East	North
Location:	Temporary bridge			Right Bank	310674	755488
				Left Bank	310707	755463

N.	Date (1)	Time (2)	Sample (3)	Chainage (4)	Depth Sp(5)	Speed (6)	Depth Sa(7)	TSS (8)
	dd/mm/yy	hh:mm	ID	m from RB	m	m/sec	m	mg/l
1	28/03/2008	10.05	26_03_08/1	31.5	0.1	1.870	0.5	173
2	28/03/2008	10.10	26_03_08/2	28.0			0.5	133
3	28/03/2008	10.15	26_03_08/3	25.0	0.1	1.774	0.5	170
4	28/03/2008	10.20	26_03_08/4	25.0			1.5	197
5	28/03/2008	10.25	26_03_08/5	22.0			0.5	193
6	28/03/2008	10.30	26_03_08/6	18.5	0.1	1.691	0.5	140
7	28/03/2008	10.35	26_03_08/7	18.5			1.5	150
8	28/03/2008	10.40	26_03_08/8	15.0			0.5	137
9	28/03/2008	10.45	26_03_08/9	12.5	0.1	1.624	0.5	166
10	28/03/2008	10.50	26_03_08/10	12.5			1.5	100
11	28/03/2008	10.55	26_03_08/11	10.5			0.5	83
12	28/03/2008	11.00	26_03_08/12	8.5	0.1	1.382	0.5	147
13	28/03/2008	11.05	26_03_08/13	8.5			1.5	80
14	28/03/2008	11.10	26_03_08/14	6.0			0.5	93
15	28/03/2008	11.15	26_03_08/15	3.0	0.1	0.819	0.5	113
					AVG (m/sec)	1.527	AVG (mg/l):	138

Remarks:

(1) Measurement date
(2) Measurement time
(3) Field sample code
(4) Chainage from the right bank
(5) Speed measure depth
(6) Punctual water speed
(7) Sampling depth
(8) TSS content retained at 95 grade filter paper

Figure 7.4: TSS and water speed sampling at temporary bridge.

7.2 – 2nd April 2008 sampling

On 2nd April 2008, coinciding with the Gibe I – Gibe II sampling set, a new sampling was performed at the temporary bridge station.

The average TSS content of the measures performed along the section was 501 mg/l, mainly influenced by the close rainy events at dam site area. Samples for the measure of the nutrients have been furthermore collected and sent to the Water Technology Institute of Arba Minch for analysis. The results are shown in the following table:

Parameters	Unit		S.20	S.21	S.22	S.23
TDS	mg/l		60	59	61	61
Phosphate PO_4^{3-}	mg/l		1.01	1.25	1.11	0.89
Nitrate as NO_3^-	mg/l		5.8	7.3	7.9	6.5
Nitrite as NO_2^-	mg/l		1	3	6	8
TSS	mg/l		540	470	527	437

From the values listed in table, phosphate is stable around 1 mg/l while Nitrate and nitrite show a wider range between 5.8 and 7.9mg/l for the first one and between 1 and 8 mg/l for the second.

In the last row the values of the total suspended solids have been added. In figure 7.5 a chart shows the trend of the nutrients value.

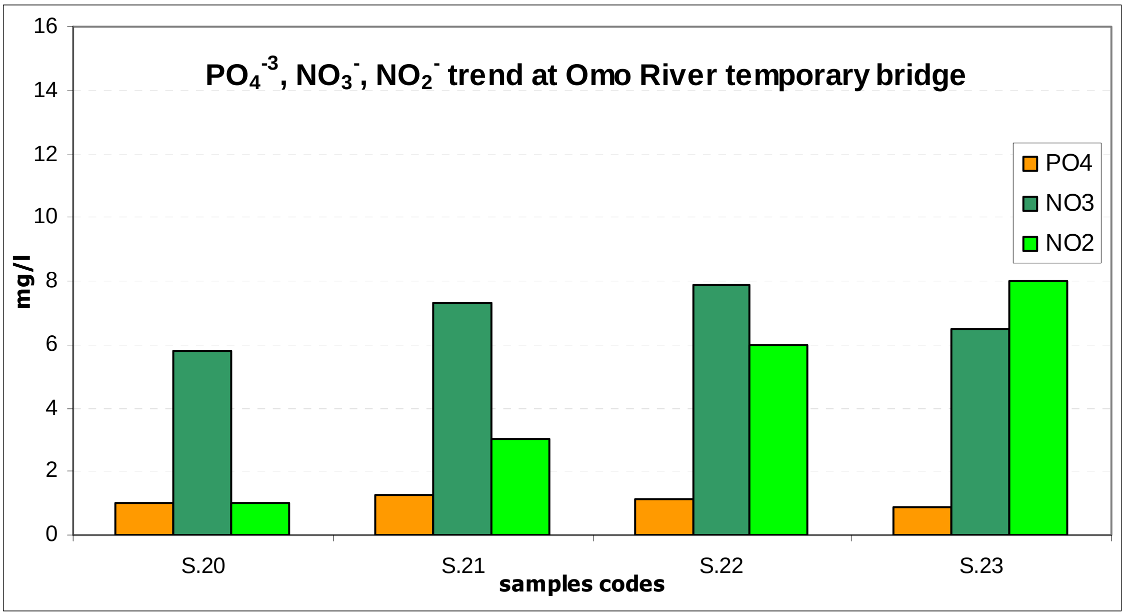


Figure 7.2.1: Chart of concentration for PO4-3, NO3-, NO2-

Biological and chemical oxygen demand have been also tested and reported in the chart below.

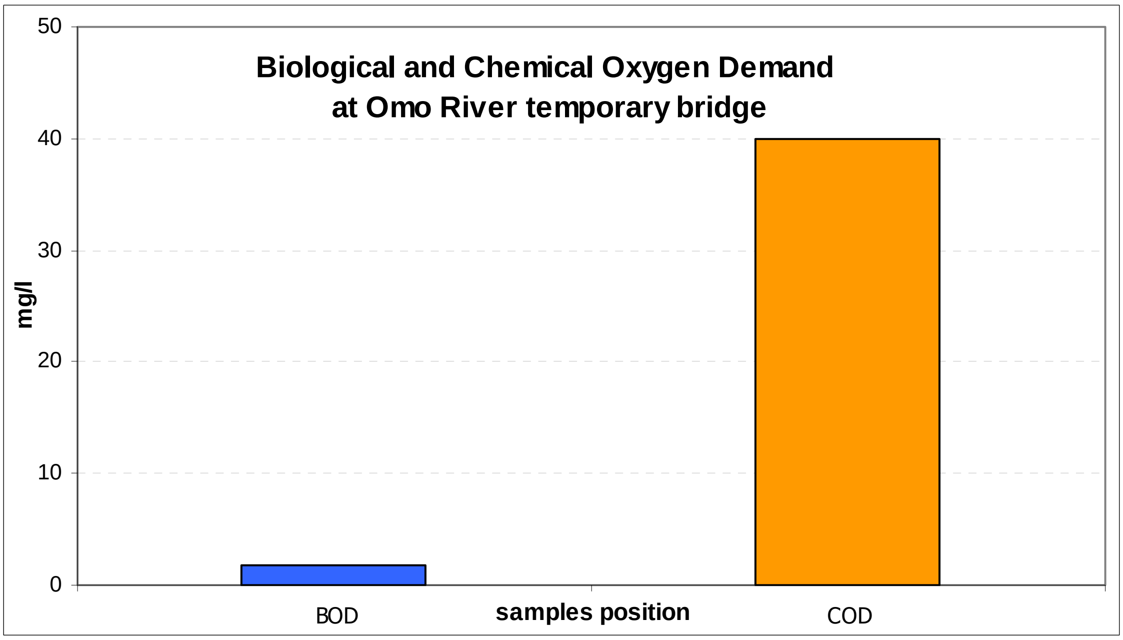


Figure 7.2.2: Chart of Biological and chemical oxygen demand.

8. Gibe I-Gibe II system

In order to ascertain whether the stop of the natural river flow caused by a weir could produce substantial changes in the water quality, and in particular about the amount of suspended nutrients, some water samples have been collected and analyzed in Gibe I dam area, in what we have already defined as Gibe I-Gibe II system.

Gibe I dam with the close upstream and the downstream river segments have been selected as one to one scale model in order to understand the possible future modification induced by Gibe III dam in the Omo river solids and nutrients transport.

Different sets of samples have been collected along the Gibe river course at Asendabo bridge, located upstream the catchments, at Gibe I reservoir (intake area) and at Gibe II intake, considered as the downstream segment of system.

The water collected upstream on April 1 was particularly clear, probably far from concentrated rainy events, and with a TSS content of 61 mg/l. The concentration reaches an average value of 103 mg/l in the reservoir, with low values (63 and 48 mg/l) one and three meters below the water surface. The water collected at different depth shows different turbidity going down to the bottom.

The downstream sampling station records an average suspended solid content of 88 mg/l.

The range of difference between the upstream and downstream stations (27 mg/l) is negligible and it should be considered representative of the dry season.

In figures 8.1 the chart shows the content of the suspended solids for each site.

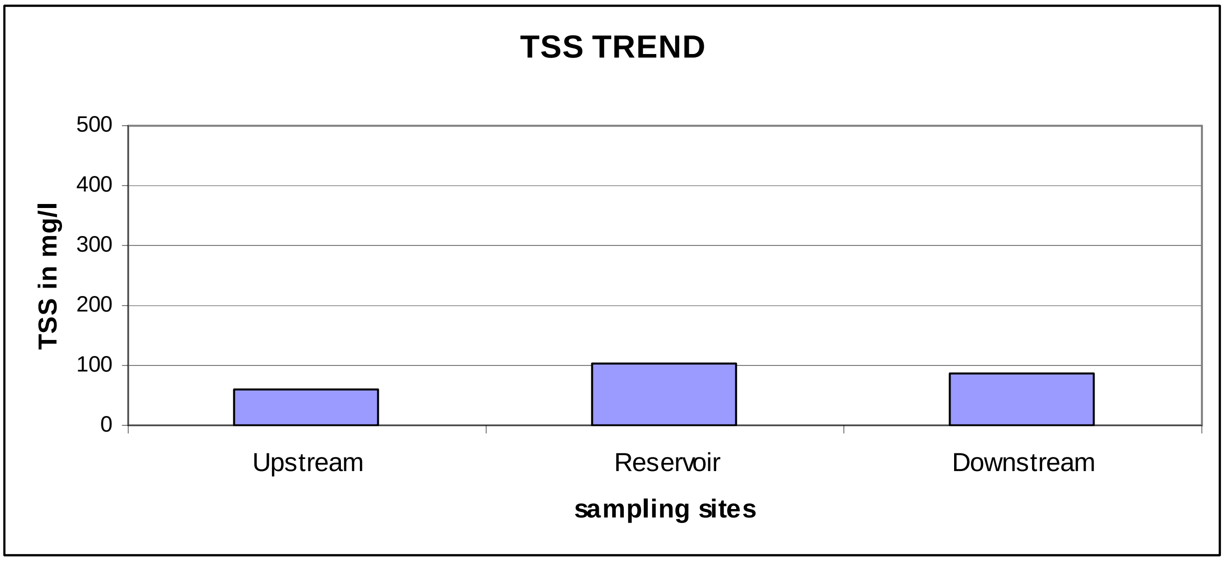


Figure 8.1: TSS content in the Gibe I – Gibe II water transport system.

In order to better assess the behaviour of the system in water transport, the content of PO_4^{-3}, NO_3^-, NO_2^- was determined. Samples collected in the three different places were delivered to the Water Technology Institute of Arba Minch.

In the following table the results are reported.

SAMPLING STATION:		ASENDABO BRIDGE (UPSTREAM)				GIBE I RESERVOIR (RESERVOIR)				GIBE II - INTAKE (DOWNSTREAM)			
PARAMETERS	UNIT	S.1	S.2	S.3	S.4	S.6	S.7	S.8	S.9	S.11	S.12	S.13	S.14
TDS	mg/l	58	62	61	59	57	57	59	57	60	57	59	59
Phosphate PO_4^{3-}	mg/l	0.9	0.9	0.9	1.0	1.8	0.7	0.7	1.4	1.3	0.9	0.9	1.1
Nitrate as NO_3^-	mg/l	0.8	1.4	0.9	1.8	12.1	4.5	4.1	5.4	4.4	4.3	5.9	5.9
Nitrite as NO_2^-	mg/l	1.0	2.0	2.0	2.0	1.0	2.0	0.0	4.0	4.0	1.0	3.0	0.0

Both living and dead suspended organic particulate material, the “seston”, will settle out by physical processes and these data fix the trend of transport in a preliminary way but with extremely concrete and systematic approach.

In Figure 8.2 the trend of phosphate, nitrate and nitrite is shown.

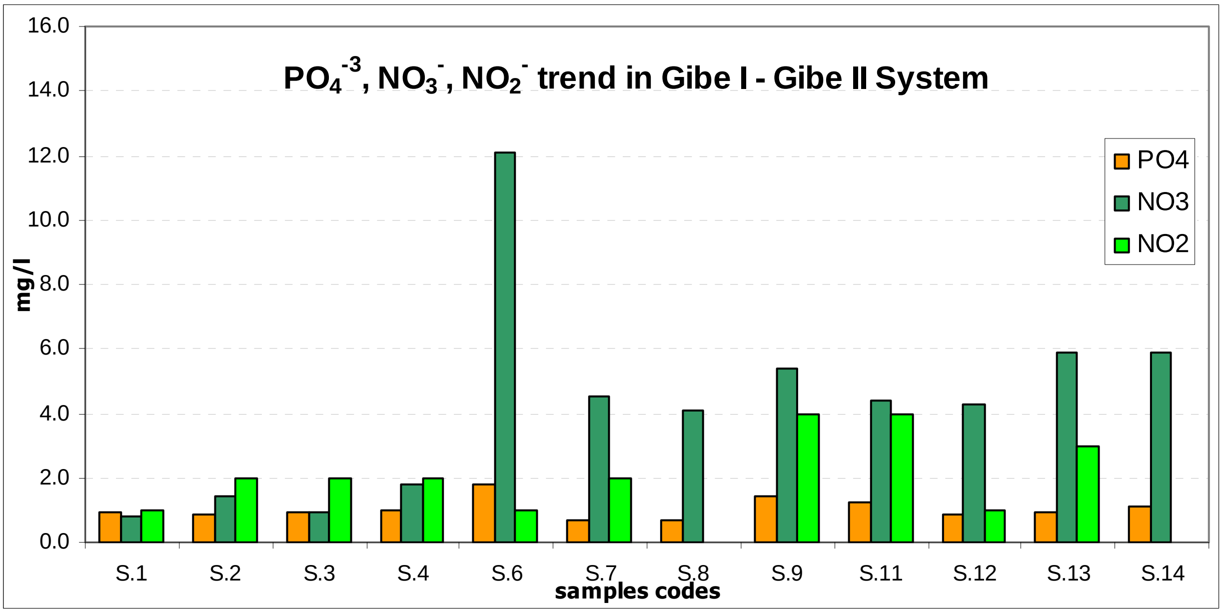


Figure 8.2: Chart of concentration for PO4-3, NO3-, NO2-

Samples S.1, S.2, S.3 and S.4 in orange colour in table and chart represent the samples collected at the Asendabo Bridge, the upstream location of the system. The average of the values is 0.9 mg/l for the phosphates, 1.2 mg/l for the nitrates and 1.8 mg/l for the nitrites.

Samples S.6, S.7, S.8 and S.9 in dark green colour in table and chart represent the samples collected at the Gibe I reservoir, where the flow loose its energy slowly settling out the sediments. The new status of the river will have a new tendency to increase the processes of eutrophication. The average of the values is 1.1 mg/l for the phosphates, 6.5 mg/l for the nitrates and 1.8 mg/l for the nitrites.

Samples S.11, S.12, S.13 and S.14 in light green colour in table and chart represent the samples collected at the Gibe II intake, the downstream location of the system. The average of the values is 1.0 mg/l for the phosphates, 5.1 mg/l for the nitrates and 2.0 mg/l for the nitrites.

The following chart summarizes the trend of the system for the three parameters.

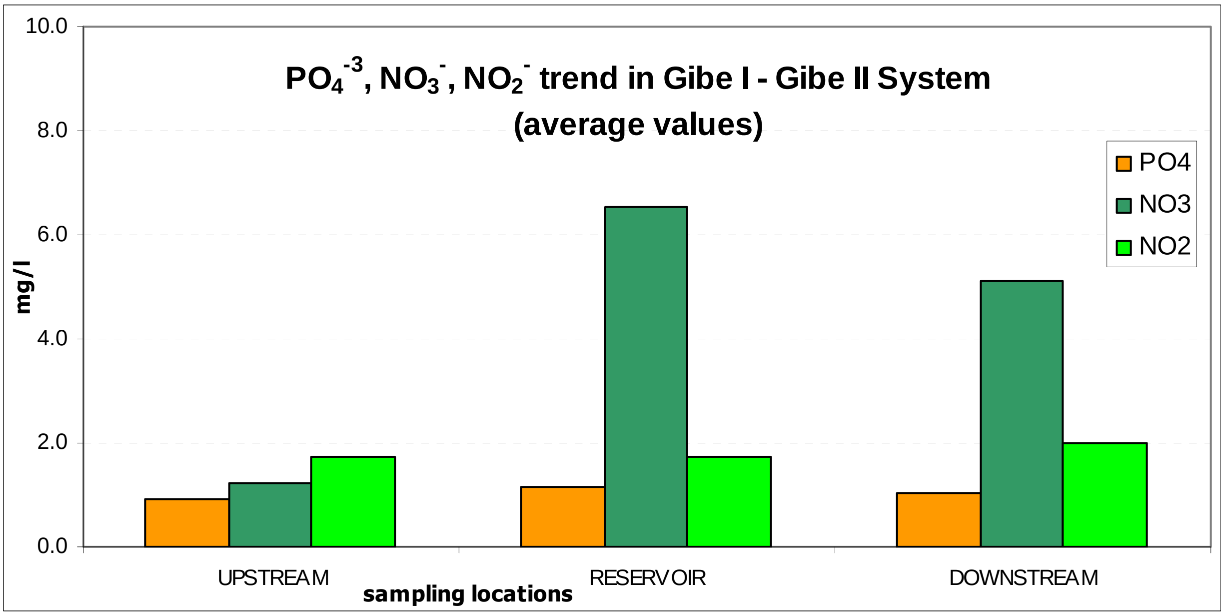


Figure 8.3: Trend of average values of PO43-, NO3- and NO2- in Gibe I – Gibe II System.

Conductivity and TDS reflect the same chemical composition of the Omo river. Phosphates and Nitrites do not show any substantial changing due to the stop of the flow in the steady water. The average content of Nitrates increase during the steady period in the reservoir and the value is approximately maintained in the downstream station.

As underlined before, jointly together with the chemical analysis listed and charted above, Total Suspended Solids analysis on samples collected at the same time in the same place have been performed.

In order to have a more complete vision of the organic material suspended in the water,

- Chemical Oxygen Demand
- Biological Oxygen Demand

have been furthermore analyzed. Data on BOD highlight the amount of oxygen measured in mg/L required for the decomposition of organic matter by single-cell organisms, and data on COD show the amount of oxygen consumed in the oxidation of organic and oxidizable inorganic matter. Contrary to BOD, with COD practically all compounds are fully oxidized.

In the following table the results of BOD and COD are shown.

SAMPLING STATION:		ASENDABO	GIBE I	GIBE II
		UPSTREAM	RESERVOIR	DOWNSTREAM
PARAMETERS	UNIT	S.5	S.10	S.16
TDS	mg/l	58	59	59
BOD	mg/l	2.23	1.93	1.67
COD	mg/l	60	50	38

The trend of the values seems decrease along the line of the system with a low margin. Charts 8.4 and 8.5 evidence the trend.

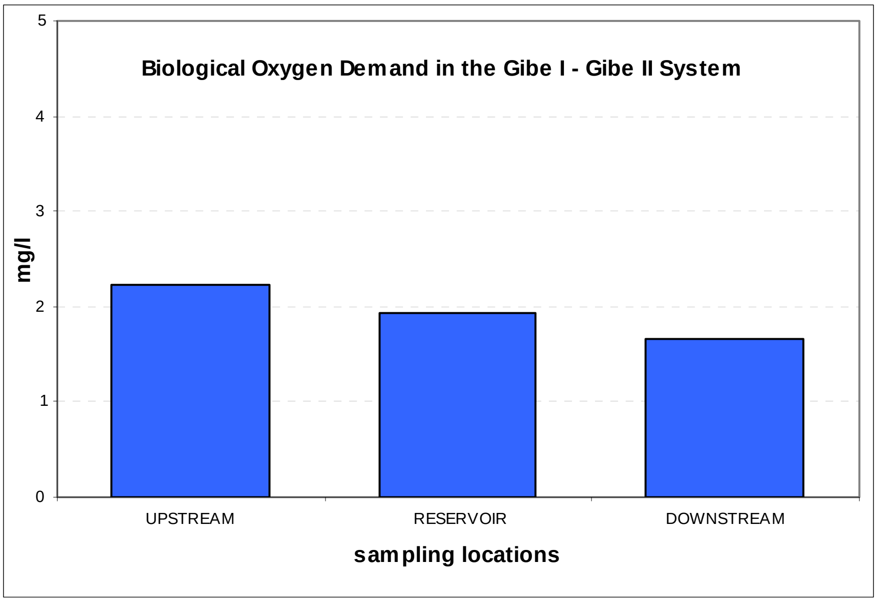


Figure 8.4: Biological Oxygen Demand measured in the three locations.

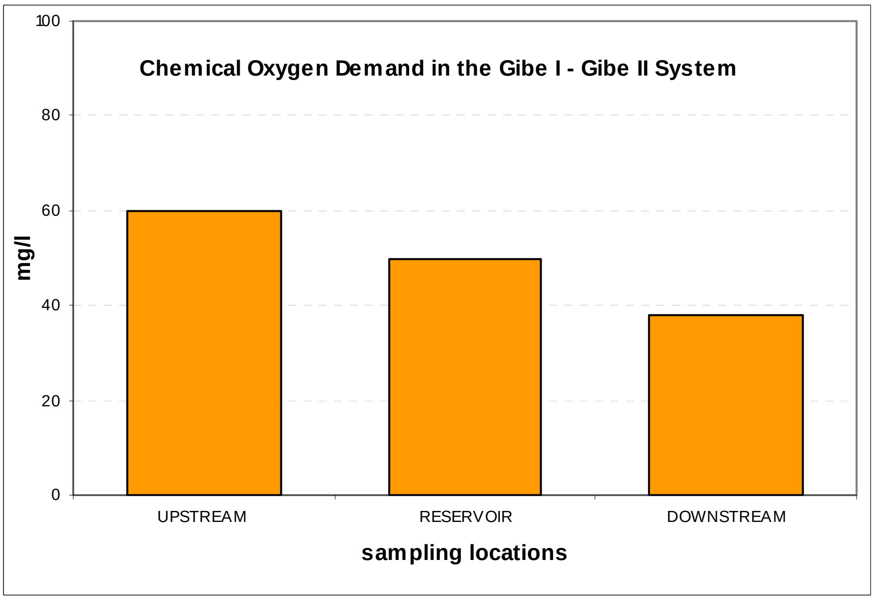


Figure 8.5: Chemical Oxygen Demand measured in the three locations.

9 – Gibe system and Omo river: compared values

A global assessment of the parameters collected in Gibe I – II and III stations is illustrated in this chapter.

The following charts show the variation of the parameters of Gibe I – Gibe II system together with the TSS and chemical parameters collected at the same time at temporary bridge station in the Omo river.

The difference of the TSS content is quite evident due probably to local rainy events. It is useful remember that the average TSS content in the Omo river during the dry season is around 130 – 140 mg/l.

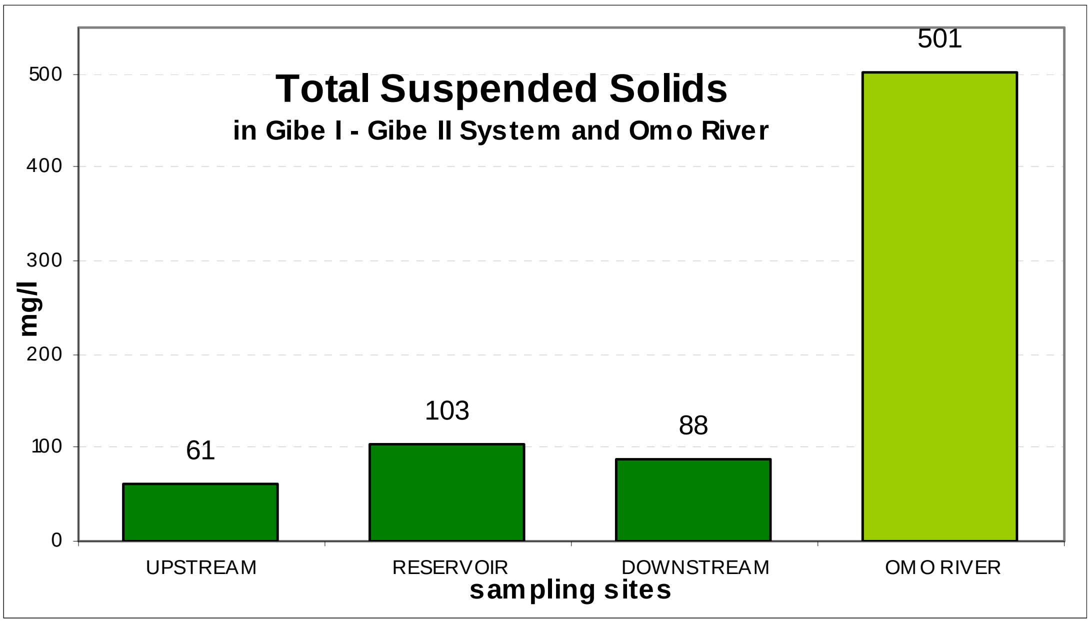


Figure 9.1: TSS content in Gibe I – Gibe II system and in the Omo river.

In the same way the breakdown of PO_4^{3-}, NO_3^- and NO_2^- in Gibe I – Gibe II System and Omo river is charted.

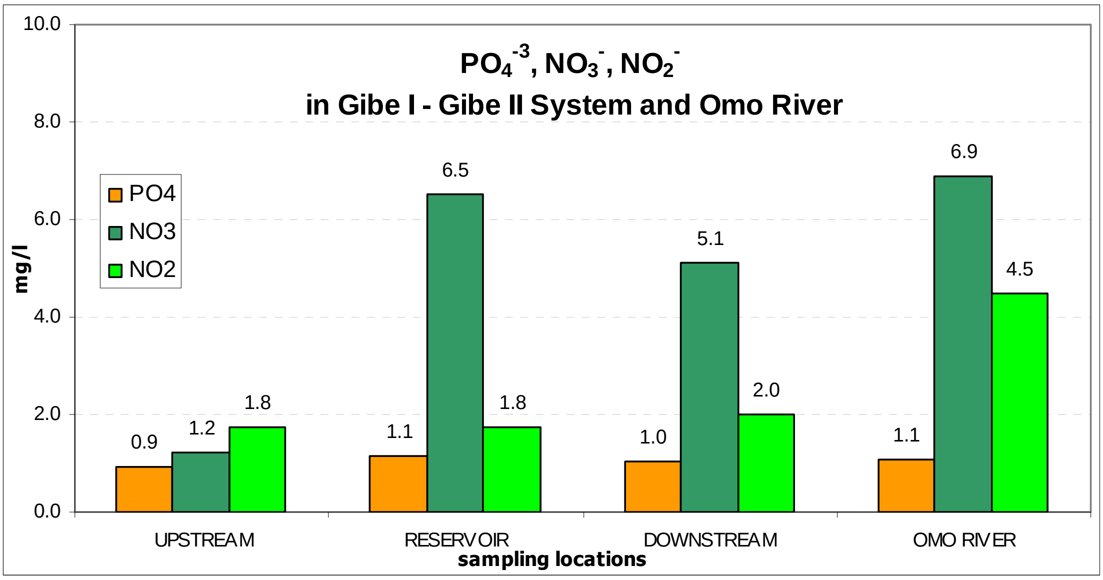


Figure 9.2: Trend of phosphate, nitrate and nitrite in the system and in the Omo river.

The content of the three parameters analysed in the upstream station is low, increasing after a steady period in the reservoir. A feebly increasing is recorded for nitrates and nitrites at the Omo river sampling station.

On the basis of the standard values known for groundwaters and superficial waters, the variation of these parameters in the system and in Gibe III station is considered negligible.

The Chemical and Biological Oxygen Demands comparison between the system stations and the Omo river station is shown in the following charts. The trend for both the parameters is quite similar with the downstream station having almost the same value of the one on the Omo river.

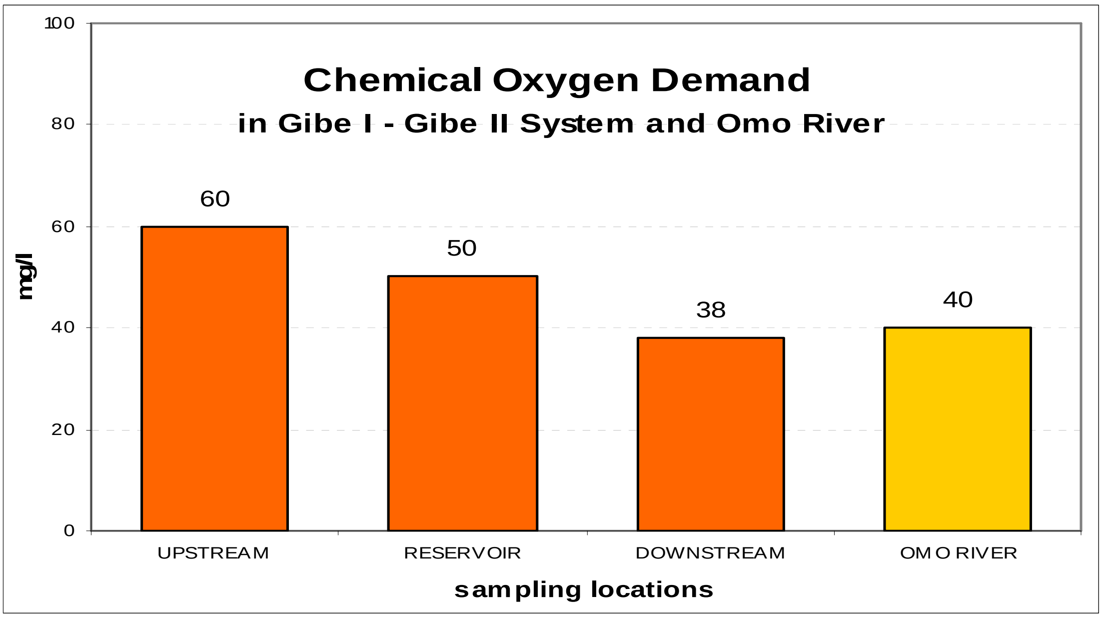


Figure 9.3: COD in the system stations and at Omo river temporary bridge.

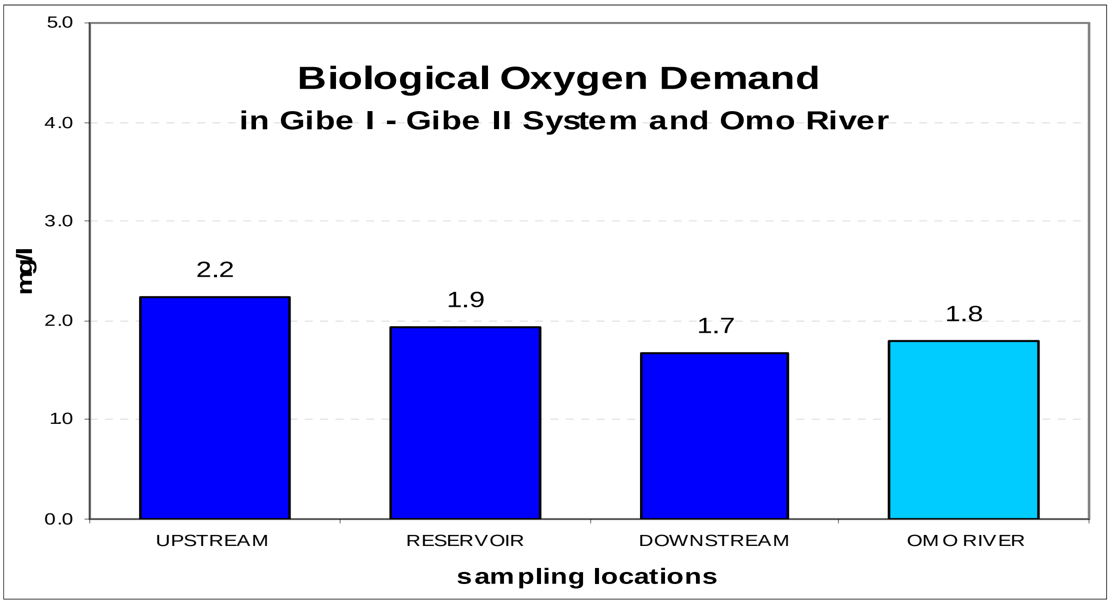


Figure 9.4: BOD in the system stations and at Omo river temporary bridge.

10 - Summary

In order to assess the basic conditions related with the suspended solid transport in the Omo river, some preliminary analysis have been carried out. The collected suspended solids consist of the sediment found on the streambed that is transported by water, especially during high flows.

The main nourishing elements present in the water have been investigated trying to get base information on TSS-organic particles interaction.

During the period February – March 2008, TSS analysis of Omo river water samples have been performed.

For the analysis the paper filter method with Ahlstrom paper 95 grade having filtration speed of 14 ml/min and 1.5 µm of retention have been used.

A standard section was selected for the measures at the temporary bridge located downstream the dam site narrow. Daily TSS data were inserted in apposite forms where the content is associated with related parameters such as depth, punctual speed, date and time of recording. The first measures gave approximate average values of 130-140 mg/l in the dry season (February – March) and around 500 mg/l at the beginning of the rainy events (April) with punctual flows showing values around 2 m/sec with top speed over 2.5 m/sec..

Phosphorus and nitrogen are the primary nutrients in most of the reservoirs. Of these, phosphorus is the least abundant of the major nutritional and structural components of biota, and it is removed from aquatic systems rather rapidly and becomes stored in sediments, where its concentration may be 2 orders of magnitude greater than the concentration in the overlying water.

To have a preliminary vision of the nutrients content in the Omo river different water samples were submitted to a specialized laboratory care of the Arba Minch University for chemical analysis.

Results show an average concentration in PO_4^{-3} of 1.1 mg/l, NO_3^- of 6.9 mg/l and NO_2^- of 4.5 mg/l.

BOD and COD have been also measured getting results of 1.8 and 40 mg/l respectively.

In order to ascertain whether the stop of the natural river flow caused by a weir could produce substantial changes in the water quality, and in particular about the amount of suspended solids and nutrients, some water samples have been collected in Gibe I dam area selected as 1:1 scale model and reflecting although with minor volumes the future physical conditions of Gibe III dam.

Different sets of samples have been collected along the Gibe river course at Asendabo bridge, located upstream the catchments, at Gibe I reservoir (intake area) and at Gibe II intake, considered as the downstream segment of system.

The range of difference of TSS between the upstream and downstream stations is 27 mg/l; the decreasing amount is negligible and it should be considered representative of the dry season.

The content of PO_4^{-3}, NO_3^-, NO_2^- was determined. Samples collected in the three different places were delivered to the Water Technology Institute of Arba Minch.

Also for these parameters the differences are not significant but for the Nitrate sensitively increasing in the reservoir station and downstream with values from 1.2 to 6.5 to 5.1 mg/l.

For a more complete vision of the organic material suspended in the water, Chemical Oxygen Demand and Biological Oxygen Demand have been furthermore analyzed.

On the basis of the biological oxygen demand analysis, the reduction of the organic matter is constantly notable with values decreasing from 2.23 to 1.93 to 1.67 mg/l.

The chemical oxygen demand follows the same trend of the system decreasing from 60 to 50 to 38 mg/l.

At last, the parameters measured in the Gibe I – Gibe II system have been compared with the same collected at the temporary bridge sampling station, on the Omo river.

The values, mainly linked at the dry season conditions, don’t show appreciable variations but the TSS content occasionally related to strong and concentrate rainy events.

Appendix 8: Minutes of Public Consultation Meetings

Appendix 8.1: Sample Unofficial Translation of the Transcriptions of the Consultations Held

Transcription of 'preliminary consultative meeting' (PCM) held between experts of the consulting firm (MDI) and 'Down Stream Zone Officials' concerning Gibe 3 'Hydro-Electric Power Project'.

Place/Venue of the PCM:	*ZARD Office*	***Date:***	*13/05/07*
Zone:	*South Omo*	***PCM composition:***	*Zone Officials and represent of MDI*
Wereda:		***Number of participants:***	*03*

The PCM members are composed of Zone Officials and MDI representatives and the outcomes of the PCM is shown below.

The project will affect the livelihoods of the communities living in four Weredas (Hamer, Salamago, Dasenech and Nyangatom) and specifically these include:

- The overflow of the river creates fishponds that are important sources of food and income and these opportunities will be lost as a result of the construction of the dam;
- Loss of grazing lands and water ponds which use for livestock; and
- Crop production could be undermined and thus poverty will be aggravated as producers do not use flood plains.

To avert the adverse condition the discussants have suggested that the communities especially that are located at the river banks should be provided with improved fishing gears and improved methods fish production.

Place/Venue of the PCM:	*Wereda Administration Office*	***Date:***	*17/12/07*
Zone:	*South Omo*	***PCM composition:***	*Wereda Officials and represent of MDI*
Wereda:	*Hamer*	***Number of participants:***	*07*

The PCM members are composed of officials and MDI representatives. The major focus of the PCM include:

- To learn and understand the effects that down stream communities would experience following the hydro electric dam that is going to be built in the upper stream of Omo River; and
- To explore appropriate mitigation measures to avert the adverse effects that might have been encountered by the newly dam to be set up.

Major outcomes of the PCM is summarised in the following manner. It was unravelled to the consultative group that:

- Substantial numbers of pastoralists in downstream communities use flood plains (the river banks) to grow crops (mostly maize and sorghum) following the overflow of Omo River during the rainy season and subsequently after the flood waters have receded;
- The community use the pond as a source of food as they catch fish from these places which have been created by the overflow of the River;
- The community aptly consider the Omo River as their source of livelihood for both food and income; and
- Most of the pastoral communities use Omo River as the only source for their livestock during the dry season; they are in doubt of using it for their animals during this season for the ostensible reason that the water that drains from the dam has become polluted.

They suggested measures to be taken in order to avert the adverse conditions that might have been created by the project such as:

- The provision of irrigation using solar energy as the source of pumping the water to farmlands; and
- The setting up of social infrastructural services to promote the wellbeing of the community.

Place/Venue of the PCM:	*Wereda Administration Office*	***Date:***	*7/05/07*
Zone:	*South Omo*	***PCM composition:***	*Wereda Officials and represent of MDI*
Wereda:	*Hamer*	***Number of participants:*** *17*	

The PCM members are composed of officials of the Wereda who are serving under various capacities and MDI representatives. The major themes of the PCM include:

- To learn and understand the effects that down stream communities would experience following the hydro electric dam that is going to be built in the upper stream of Omo River; and
- To explore appropriate mitigation measures to avert the adverse effects that might have been encountered by the newly dam to be set up.

Major outcome of the PCM is summarised in the following manner. It was unravelled to the consultative group that:

- Substantial numbers of pastoralists in downstream communities use flood plains (the river banks) to grow crops (mostly maize and sorghum) following the overflow of Omo River during the rainy season and subsequently after the flood waters have receded.
- Downstream crop productions under such system commonly cover the food needs of the households about six months.
- Quasi lakes are also created by the overflows where down stream communities’ use for fishing.
- Once the hydro-electric dam is in place constant flow will set in, with no more swelling of the Omo River to cause flooding in downstream areas and thus depriving the pastoral communities grazing areas and croplands including pools of water for fishing.

In order to avert these adverse effects the consultative team believe that the following measures should be taken and these include:

- The promotion of irrigation for growing crops and grasses and fodder for livestock;
- The provision and expansion of basic services; and
- Adopting various actions that strengthen the livelihood system of the communities.

Place/Venue of the PCM:	*Kebele Office*	***Date:***	*10/05/07*
Zone:	***South Omo***	***PCM composition:***	*Kebele leaders and members and MDI*
Wereda:	*Hamer*	***Number of participants:*** *40*	
Kebele:	*Karadus*		

The PCM members are composed of Kebele leaders and members including MDI representatives. The major themes of the PCM include:

- To learn and understand the effects that down stream communities would experience following the hydro electric dam that is going to be built in the upper stream of Omo River; and
- To explore appropriate mitigation measures to avert the adverse effects that might have been encountered by the newly dam to be set up.

Major outcome of the PCM is summarised in the following manner. It was made known to the consultative group that:

- The Omo River has always been the lifeblood of the community providing essential water source for their livestock and crop production;
- Substantial numbers of community members in Hamer use flood plains to grow various crops like: maize, sorghum, soya and haricot beans and etc., both for consumption and for sale;
- Plants growing on the flood plains have flowers use for harvest honey;
- When the lakes are filled with flood water they use for irrigation to produce food crops and the surplus is bartered for livestock and milk; and
- They catch fish from the lakes for the purpose of household consumption and for marketing.

The absence of flooding will make the communities in a state of precarious balance between survival and deprivation. With the view to encounter such a situation they believe intensifying irrigated agriculture should be taken as the major focus of agriculture production in their communities.

Place/Venue of the PCM:	*Kebele Office*	***Date:***	*18/12/07*
Zone:	*South Omo*	***PCM composition:***	*Kebele leaders and members and MDI*
Wereda:	*Hamer*	***Number of participants:***	*25*
Kebele:	*Kara korcho*		

The PCM members are composed of kebele leaders and members including MDI representatives. The major themes of the PCM include:

- To learn and understand the effects that down stream communities would experience following the hydro electric dam that is going to be built in the upper stream of Omo River; and
- To explore appropriate mitigation measures to avert the adverse effects that might have been encountered by the newly dam to be set up.

Major outcome of the PCM is summarised in the following manner. It was made known to the consultative group that:

- The Omo River has always been the lifeblood of the community providing essential water source for their livestock and crop production.
- Substantial numbers of community members in Hamer use flood plains to grow various crops both for consumption and for sale.
- They catch fish from the lakes that are filled by flood water for the purpose of household consumption and for marketing.

The absence of flooding will expose the communities to loss of income. Therefore, mitigation measures like irrigated agriculture should be introduced and intensified with the aim of crop and fodder production.

Place/Venue of the PCM:	*Wereda Administration Office*	***Date:***	*19/12/07*
Zone:	*South Omo*	***PCM composition:***	*Wereda Officials and representatives of MDI*
Wereda:	*Nayangatom*	***Number of participants:*** *12*	

The PCM members are composed of officials of the Wereda who are serving under various capacities and MDI representatives. The major themes of the PCM include:

- To learn and understand the effects that down stream communities would experience following the hydro electric dam that is going to be built in the upper stream of Omo River; and
- To explore appropriate mitigation measures to avert the adverse effects that might have been encountered by the newly dam to be set up.

Major outcome of the PCM is summarised in the following manner. It was unravelled to the consultative group that:

- Substantial numbers of pastoralists in downstream communities use flood plains (the river banks) to grow crops (mostly maize and sorghum) following the overflow of Omo River during the rainy season and subsequently after the flood waters have receded.
- Downstream crop productions under such system are used for consumption and bartering.
- Quasi lakes are also created by the overflows where down stream communities' use for fishing.
- Once the hydro-electric dam is in place, constant flow will set in, and no more swelling of the Omo River to cause flooding in downstream areas. As a result, there will not grazing areas, croplands and pools of water for fishing that may use for pastoral communities.

In order to avert these adverse effects the consultative team believe that the following measures should be taken.

- Promotion of irrigation for growing crops and grasses and fodder for livestock;
- Provision and expansion of basic services; and
- Adopting various actions that strengthen the livelihood system of the communities.

Place/Venue of the PCM:	*Wereda Administration Office*	***Date:***	*13/05/07*
Zone:	*South Omo*	***PCM composition:***	*Wereda Officials and representatives of MDI*
Wereda:	*Nayangatom*	***Number of participants:*** *03*	

The PCM members are composed of Wereda Officials and MDI representatives and outcomes of the PCM is shown below. The project will affect the livelihoods of the Nyangatom Wereda communities and specifically these include:

- Members of the communities grow crop after the overflow has receded and production from such farms are used for food and sale. The construction of the dam will change this situation adversely; and
- The overflow also makes number of grazing fields for livestock and this will be no more after the dam has been built.

In order to mitigate the adverse effect of the project, irrigated agriculture other developments should be promoted to improve the socio-economic conditions of the project affected communities.

Place/Venue of the PCM:	*Wereda Office*	***Date:***	*19/12/07*
Zone:	*South Omo*	***PCM composition:***	*Leaders and members of four Kebeles and MDI*
Wereda:	*Nayangatom*	***Number of participants:***	*15*
Kebele:	*Lurengachawe, Natkara, Shenkora, Kuchere Nargye and Aptukoyet Lokper, Aypa*		

The PCM members are composed of kebele leaders and members including MDI representatives. The major themes of the PCM include:

- To learn and understand the effects that down stream communities would experience due to the construction of hydro electric dam at the upper stream of Omo River; and
- To identify appropriate mitigation measures for the adverse effects caused by the dam;

Major outcome of the PCM is summarised below in brief:

- The Omo River is the source of the livelihood of the community that it provides water source for their livestock and crop production.
- Downstream communities in Nyangatom Wereda use flood plains to grow various crops and production collected on such lands cover the households' food needs for about three months.
- After the flood recedes, pasture lands become abundant and use to graze their cattle all year round.
- Those households who neither engage in livestock nor crop production are engaged in fish catching from the lakes created by the river flood.

The absence of flooding will jeopardise the life of the communities. Therefore, mitigation measures due to the project should be taken to assist the affected communities. Among the possible measures recommend by the participants:

- Expansion of irrigated agriculture using diesel pumps;
- Distribution of improved fishing gear and the promotion of improved fish production; and
- Construction of access road particularly bridge over the Omo River for the expansion of tourist industry. Currently there is some endeavours to promote tourist industry in the downstream zones of Omo River.

Place/Venue of the PCM:	*Wereda Administration Office*	***Date:***	*10/12/07*
Zone:	*South Omo*	***PCM composition:***	*Wereda Officials and represents of MDI*
Wereda:	*Dasanech*	***Number of participants:***	*21*

The PCM members are composed of officials of the Wereda who are serving under various capacities and MDI representatives. The major themes of the PCM include:

- To learn and understand the effects of the project on the down stream communities; and
- To explore appropriate mitigation measures to avert the adverse effects caused by the project.

The identified major issues are summarised in brief below:

- Substantial numbers of pastoralists in downstream communities use flood plains (the river banks) to grow crops (mostly maize and sorghum). Flood plains become available when Omo River overflows;
- A total of about 6,000 ha of land use for receding cultivation in the Wereda;
- Downstream crop productions under such system cover the food needs of the households for about three to six months;
- Whenever there is no adequate flooding shortfalls of production is augmented by the Government through food aid;
- About 30 spots of pasture lands or islands become apparent in the Wereda due to the overflow of the river. The pastureland serve the communities for grazing all year round;
- Quasi lakes are also created by the overflows of the river where down stream communities' use for fishing. They are source of income and food for Desanech communities; and
- The implementation of the project will affect the pasturelands and fishing activities of the downstream communities so that they will not have the indicated sources of income for their livelihood.

In order to avert these adverse effects the consultative team believe that possible measures should be taken, among which include:

- Irrigation in the Wereda is rudimentary and the scope should be expanded at least to offset the production losses from the estimated 6,000 ha of croplands;
- Development of pastureland irrigation for livestock;
- Appropriate marketing services for livestock and expansion of basic services; and
- Adopting various actions that strengthen the livelihood system of the communities.

Place/Venue of the PCM:	*Wereda Administration Office*	***Date:***	*11/05/07*
Zone:	*South Omo*	***PCM composition:***	*Wereda Officials and represents of MDI*
Wereda:	*Dasanech*	***Number of participants:***	*09*

The PCM members are composed of Wereda officials and MDI representatives and it was evident from the discussion that the project will affect the livelihoods of the Desanech Wereda communities and specifically these include:

- The livelihood of the Desanech community is based on the Omo River. Flood plain cultivation is vital source of food and income to the households;
- Fishery is the second most important livelihood source to produce food and cash to the communities;
- Pasture lands created by the overflow of the river are vital sources of foraging for their livestock.

Adverse effects resulting from the construction of the dam should be mitigated and such measures should include introduction of diesel pump for irrigation and improved methods of fishing.

Place/Venue of the PCM:	*Kebele Office*	***Date:***	*11/05/07*
Zone:	*South Omo*	***PCM composition:***	*Kebele leaders and members and MDI*
Wereda:	*Dasenech*	***Number of participants:***	*33*
Kebele:	*Rate*		

The PCM members are composed of Kebele leaders and members including MDI representatives. The major themes of the PCM include:

- To learn and understand the effects that down stream communities would experience due to the construction of hydro electric dam in the upper stream of Omo River; and
- To explore appropriate mitigation measures to avert the adverse effects caused by the dam.

The identified major issues are summarised in brief below:

- Swelling of Omo River is a blessing for floods on the plains that the communities of Desanech use for crop production. Absence of flooding will bring famine and starvation to the communities;
- Flood the river make possible to grow maize and sorghum for consumption and marketing;
- Flood waters create fishponds which are vital sources of food and income.
- Pasture lands created by the flood of the river are the main sources of grazing lands for pastoralists.

The absence of flooding will make the communities livelihood insecure. To mitigate this adverse condition, the community members urge to further advance the current irrigation practices that are underway with the assistance of the Government and other development practitioners.

Place/Venue of the PCM:	*Kebele Office*	***Date:***	*20/12/07*
Zone:	*South Omo*	***PCM composition:***	*Kebele leaders and members and MDI*
Wereda:	*Dasenech*	***Number of participants:*** *45*	
Kebele:	*Lobet*		

The PCM members are composed of kebele leaders and members including MDI representatives. The major themes of the PCM include:

- To learn and understand the effects of the project on the down stream communities; and
- To explore appropriate mitigation measures to avert the adverse effects caused due to the construction of the Dam;

The consultative group raised major issues with regard to the possible impacts of the project. The points are summarized below:

- The Omo River has always been the lifeblood of the community providing essential water source for their livestock and crop production;
- When riverbanks are adequately (not in catastrophic proportion) flooded communities in Desanech could grow crops primarily for consumption all through the year and any surplus obtained is sold or bartered in the market;
- Pasture lands which are created by the river out flows is the main grazing source for cattle all year round; and
- Fishing in the lakes created by the floods is very common and the product uses for household consumption and marketing.

The absence of river flood will bring problems on the livelihood of the communities. Thus possible mitigation measures should be identified and implemented. These include:

- The expansion of irrigated agriculture as it is currently underway has proven to be practical while pastoralist have begun to produce fruits and vegetables for markets.
- As grazing plains cease to grow grass with the absence of flood waters, it is important that well water be installed for human and livestock use.
- Improved varieties of fodder should be introduced so that pastoralists will not depend on grazing, and
- Improved varieties of vegetable seeds should be distributed in order to promote the development of cash crops.

Place/Venue of the PCM:	*Wereda Administration Office*	***Date:***	*15/12/07*
Zone:	*South Omo*	***PCM composition:***	*Wereda Officials and represent of MDI*
Wereda:	*Selamago*	***Number of participants:*** *09*	

The PCM members are composed of officials of the Wereda who are serving under various capacities and MDI representatives. The major themes of the PCM include:

- To learn and understand the effects of the project on the down stream communities; and
- To explore appropriate mitigation measures to avert the adverse effects caused by the construction of the Dam.

Major issues raised by the communities are summarized in brief below:

- Substantial numbers of pastoralists in downstream communities use flood plains (the river banks) to grow crops mostly maize and sorghum following the overflow of Omo River occurred during the rainy season. They use the plains after the flood waters have receded;
- Downstream crop productions under such system are used for consumption and bartering;
- Quasi lakes are created by the overflows use for fishing. It is the source of income for downstream communities;
- The implementation of the project will bring adverse impacts or livelihood of the downstream communities for the fact that there will not be river out flows to create quasi lakes and flooded pasture lands.

In order to avert these adverse effects the consultative team believe that the following measures should be taken and among which include:

- Irrigated agriculture should be introduced to advance both crop and livestock production;
- Fish farming should be introduced/expanded; and
- Adopting various actions that strengthen the livelihood system of the communities.

Place/Venue of the PCM:	*Wereda Office*	***Date:***	*15/12/07*
Zone:	*South Omo*	***PCM composition:***	*Leaders of the two Kebeles and members and MDI*
Wereda:	*Selamago*	***Number of participants:*** *32*	
Kebele :	*Omohana and Gura*		

The PCM members are composed of kebele leaders and members including MDI representatives. The major themes of the PCM include:

- To learn and understand the effects of the project on the down stream communities; and
- To explore appropriate mitigation measures to avert the adverse effects caused by the construction of the Dam.

The major raised issues during the discussion include:

- The Omo River has always been the lifeblood of the communities for it provides essential water source for their livestock and crop production;
- Downstream communities in Salamago Wereda use flood plains to grow various crops. Income from such sources could maintain the households' food needs for about three months;
- Fishponds created by the overflow of Omo are important sources of food and income to the pastoral households.

The absence of flooding will expose the communities for problems. The possible measures to mitigate the problem include introduction of irrigation agriculture and promotion of fodder production for livestock use.

Place/Venue of the PCM:	*Wereda Office*	***Date:***	*08/05/07*
Zone:	*South Omo*	***PCM composition:***	*Leaders and members of the Kebeles and MDI*
Wereda:	*Selamago*	***Number of participants:*** *20*	
Kebele :	*Haylewa*		

The PCM members are composed of Kebele leaders and members including MDI representatives. The major themes of the PCM include:

- To learn and understand the effects of the project on the down stream communities; and
- To explore appropriate mitigation measures to avert the adverse effects of the project.

The identified major issues include:

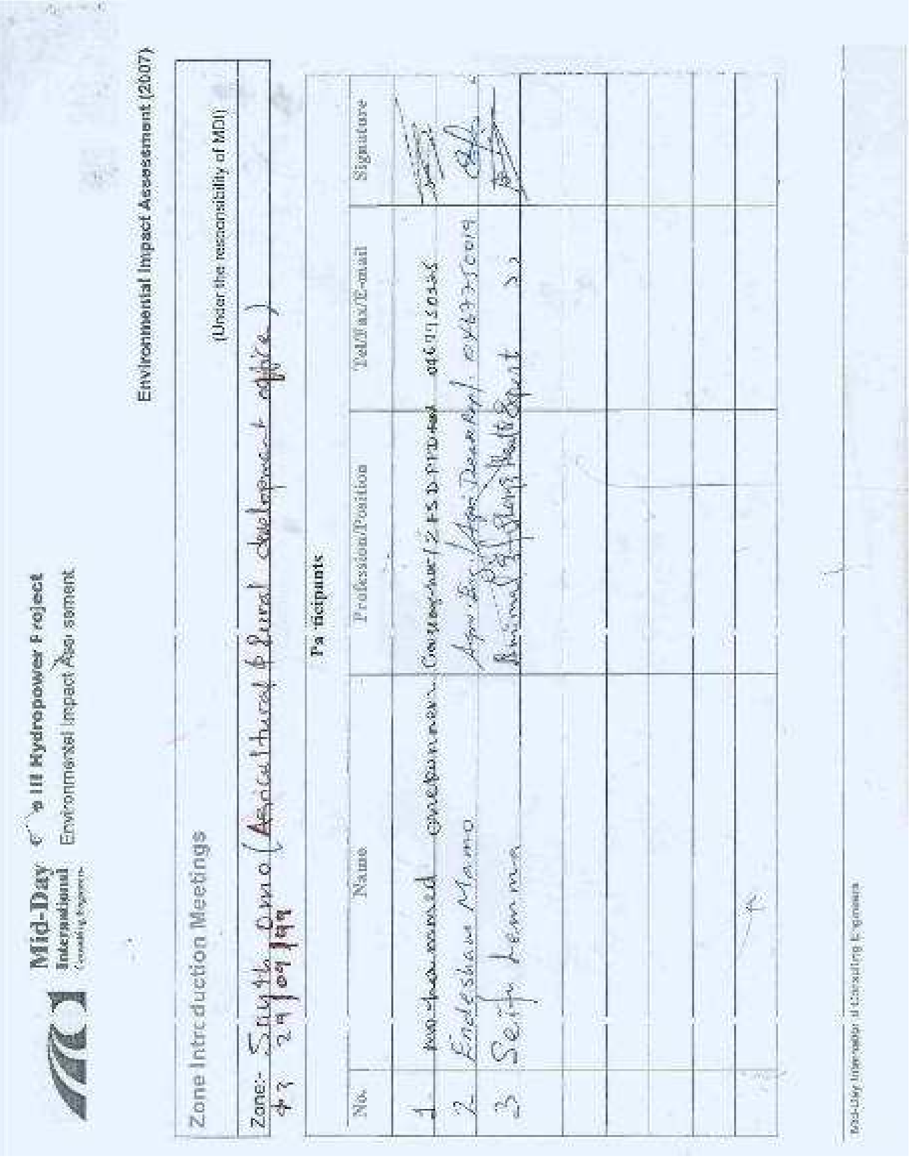
- The Omo River has always been the lifeblood of the community providing essential water source for their livestock and crop production;
- As this Wereda is characterised by low rainfall most community members rely on the flood plains to grow various crops like maize and sorghum parallel to livestock production;
- Even in normal production period (with the presence of flooding) the Wereda is known to be food deficit and the Government augments such deficit through 'safety net programme';
- Downstream Omo is very important for fishing activities. Fish is the main food for the Wereda people.

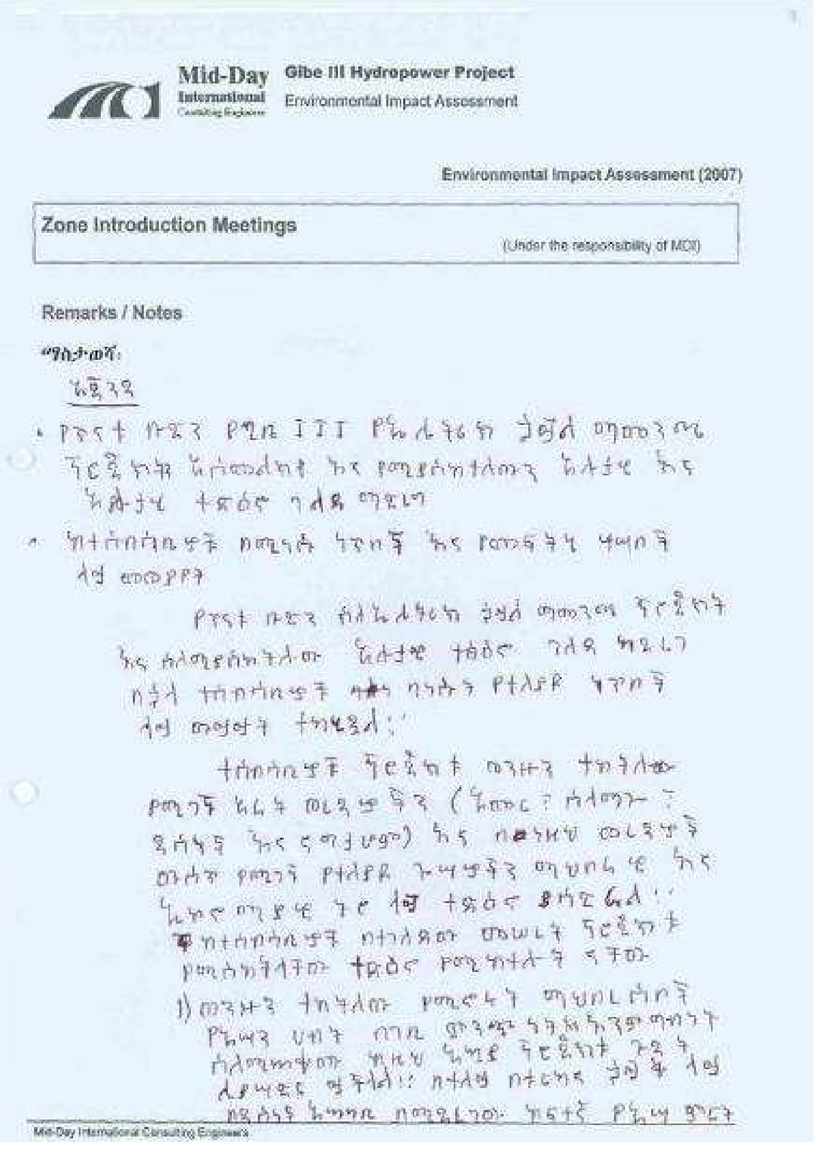
The absence of flooding will jeopardise the life of the communities if not possible mitigation are not taken on time.

Among the possible measures they recommended include:

- The expansion of irrigated agriculture using diesel pumps; and
- Distribution of improved fishing gear and the promotion of improved fish production

Appendix 8.2: Amharic Transcription of the Public Consultations Held





Mid-Day International Consulting Engineers — **Gibe III Hydropower Project** Environmental Impact Assessment

Environmental Impact Assessment (2007)

Zone Introduction Meetings

(Under the responsibility of MDI)

Remarks / Notes

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የአካባቢው ሕዝብ ከፍተኛ የገቢ ምንጭ ያገኛል።

2) ወንዙ አካባቢ ያለውን የግጦሽ ሣር በመጠቀም ከብት ያረባሉ እንዲሁም ከብቶቻቸውን ውሃ ያጠጣሉ።

3) አካባቢው በወንዙ አካባቢ የሚኖሩ ሰዎች (ሙርሲዎች) ካሆሮ ኛ (Recession cultivation) የእርሻ እንቅስቃሴ በመጠቀም የእርሻ ምርት የሚያመርቱ በመሆኑ ወንዙ አካባቢ ሲገደብ የውሃው መጠን ከፍተኛ ሁኔታ ይቀንሳል። ስለሚቀንስ ምርታማነት ከፍተኛ ሁኔታ ... [illegible] 300 ... [illegible]

በመጨረሻም ተሳታፊዎች ከዚህ በላይ በወንዙ መቀነስ ምክንያት ... [illegible] ... እንዲመቻችላቸው ጠይቀዋል።

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Mid-Day International Consulting Engineers — ሚድ-ዴይ ኢንተርናሽናል አማካሪ መሃንዲሶች

Consultation Meeting With Wereda Offices (ከወረዳ ጽ/ቤት ጋር የተደረገ ምክክር)

Point of Discussion: (የውውይት አርእስ፡) የጊቤ III የኤሌክትሪክ ... [illegible] (flood) ... [illegible]

Wereda (የወረዳው ስም)፡ ሐመር

Place of the Meeting (ውውይት የተደረገበት ቦታ፡) የሐመር ወረዳ ... [illegible]

Date (ቀን) 7/04/2000

Time (ሰዓት)

Ser. No. (ተ.ቁ)	Name (የተሳታፊው ስም)	Position (ኃላፊነት)	Telephone/Fax/Email (ስ.ቁ./ፋክስ/ኢሜል)	Signature (ፊርማ)
1	[illegible]	[illegible]	[illegible]	[signature]
2	[illegible]	[illegible]	0911490223	[signature]
3	[illegible]	[illegible]	0911943674	[signature]
4	[illegible]	[illegible]	–	[signature]
5	[illegible]	[illegible]	–	[signature]
6	[illegible]	[illegible]	0911462655	[signature]
7	[illegible]	[illegible]	0911463024	[signature]

Mid-Day International Consulting Engineers ሚድ-ዴይ ኢንተርናሽናል አማካሪ መሃንዲሶች

Consultation Meeting With Wereda Offices
(ከወረዳ ጽ/ቤት ጋር የተደረገ ምክክር)

Minutes of the Discussions (የስብሰባው ቃለጉባኤ)

[illegible] Gibe III [illegible] (flood) [illegible]

1. [illegible] (flood) [illegible]

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Mid-Day International Consulting Engineers ሚድ-ዴይ ኢንተርናሽናል አማካሪ መሃንዲሶች

Consultation Meeting With Wereda Offices
(ከወረዳ ጽ/ቤት ጋር የተደረገ ምክክር)

Minutes of the Discussions (የስብሰባው ቃለጉባኤ)

[illegible]

2. [illegible]

3. [illegible] (flood) [illegible]

[illegible] (flood) [illegible] (flood) [illegible]

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Mid-Day International Consulting Engineers ሚድ-ዴይ ኢንተርናሽናል አማካሪ መሃንዲሶች

Consultation Meeting With Wereda Offices

(ከወረዳ ጽቤት ጋር የተደረገ ምክክር)

Minutes of the Discussions (የስብሰባው ቃለጉባኤ)

[illegible]

Mid-Day International Consulting Engineers — Gi[illegible] III Hydropower Project — Environmental Impact Assessment

Environmental Impact Assessment (2007)

Wereda Introduction Meetings

(Under the responsibility of MDI)

Zone:- South Omo

Wereda:- Hammer Wereda

29/8/99

Participants

No.	Name	Profession/Position	Tel/Fax/E-mail	Signature
1	Ato Tsegaye Asfa	Administrator	(signed)	(signed)
2	Ato Andualem Lale	H/w/Agr/R/D/Deputy head		(signed)
3	" Wondiferaw Kala	Woreda Deputy Head		(signed)
4	Ermet Gashaw	Leader H/w/Youth&Sport office		(signed)
5	Walle Alima	H/w/ Adaministration office		(signed)
6	Hepur Morta	H/w/ Wo/office		(signed)
7	Taye Lowoyo	Council		(signed)
8	Shelli Ayke	Agri & Rural develop head office	0467750613	(signed)
9	Tale Biwa	Head, education	talebiwa@yahoo.com	(signed)
10	Ayigo Dore	Head, public organization	0916373[illegible]	(signed)
11	Tamirat Gezahegn	Head of Finance & Economy	0911611666	(signed)

Mid-Day International Consulting Engineers

Mid-Day International Consulting Engineers
Gibe III Hydropower Project
Environmental Impact Assessment

Environmental Impact Assessment (2007)

Wereda Introduction Meetings
(Under the responsibility of MDI)

Zone:-
Wereda:- Hammer Woreda

Participants

No.	Name	Profession/Position	Tel/Fax/E-mail	Signature
1	Tedila Goma	S. T Heade office		[illegible]
2	ESRAEL ADANE	S/M/AS/R/D/office		[illegible]
3	Gino Kosho	Information had [illegible]		[illegible]
4	Adja Lemma	Council head speaker		[illegible]

Mid-Day International Consulting Engineers

Mid-Day International Consulting Engineers
Gibe III Hydropower Project
Environmental Impact Assessment

Environmental Impact Assessment (2007)

Werada Introduction Meetings
(Under the responsibility of MDI)

Remarks / Notes

ማስታወሻ፡

[illegible]

Mid-Day International Consulting Engineers

Mid-Day International Consulting Engineers — Gibe III Hydropower Project, Environmental Impact Assessment

Environmental Impact Assessment (2007)

Werada Introduction Meetings

(Under the responsibility of MDI)

Remarks / Notes

ማስታወሻ:

[illegible] (Retreat flood / Recession cultivation) [illegible]

[illegible]

Mid-Day International — ሚድ-ዴይ ኢንተርናሽናል አማካሪ መሃንዲሶች

Consultation Meeting With Communities (ከህብረተሰቡ ጋር የተደረገ ምክክር)

Point of Discussion: (የውውይት ርእስ) [illegible]

Place of the Meeting (ውውይት የተደረገበት ቦታ) [illegible]

Date (ቀን) 8/04/2000

Time (ሰዓት)

Ser. No (ተ.ቁ)	Name of the Participant (የተሳታፊው ስም)	Wereda (ወረዳ)	PA (ቀበሌ ገበሬ ማህበር)	Village (ቀበሌ)	Position (በቀበሌ ገበሬ ማህበር ውስጥ ያለዉ ኃላፊነት)	Signature (ፊርማ)
1.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
2.	" [illegible]	"	"	"	[illegible]	
3	" [illegible]	"	"	"	[illegible]	
4.	" [illegible]	"	"	"	[illegible]	
5	" [illegible]	"	"	"	"	
6	" [illegible]	"	"	"	[illegible]	
7	" [illegible]	"	"	"	"	
8	[illegible]	"	"	"	"	

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Consultation Meeting With Communities
(ከህብረተሰቡ ጋር የተደረገ ምክክር)

Points of the Discussions (በስብሰባው የተነሱ ነጥቦች)

[illegible]

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Consultation Meeting With Communities
(ከህብረተሰቡ ጋር የተደረገ ምክክር)

Points of the Discussions (በስብሰባው የተነሱ ነጥቦች)

[illegible]

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Mid-Day International Consulting Engineers — ሚድ-ዴይ ኢንተርናሽናል አማካሪ መሃንዲሶች

Consultation Meeting With Communities
(ከህብረተሰቡ ጋር የተደረገ ምክክር)

Points of the Discussions (በስብሰባው የተነሱ ነጥቦች)

[illegible]

Mid-Day International Consulting Engineers — ሚድ-ዴይ ኢንተርናሽናል አማካሪ መሃንዲሶች

Consultation Meeting With Wereda Offices (ከወረዳ ጽ/ቤት ጋር የተደረገ ምክክር)

Point of Discussion: (የውውይት አርእስት)
Wereda (የወረዳው ስም): [illegible] ወረዳ
Place of the Meeting (ውውይት የተደረገበት ቦታ): 9/04/2000
Date (ቀን): 9/04/2000
Time (ሰዓት):

Ser. No. (ተ.ቁ)	Name (የተሳታፊው ስም)	Position (ኃላፊነት)	Telephone/Fax/Email (ስ.ቁ/ፋክስ/ኢሜል)	Signature (ፊርማ)
1	[illegible]	[illegible]	–	[signature]
2	[illegible]	[illegible]	–	[signature]
3	[illegible]	[illegible]	–	[signature]
4	[illegible]	[illegible]	–	[signature]
5	[illegible]	[illegible]		[signature]
6	[illegible]	[illegible]		[signature]
7	[illegible]	[illegible]		[signature]
8	[illegible]	[illegible]		[signature]
9	[illegible]	[illegible]		[signature]
10	[illegible]	[illegible]	–	[signature]
11	[illegible]	[illegible]	–	[signature]
12	[illegible]	[illegible]		[signature]

Mid-Day International Consulting Engineers ሚድ-ዴይ ኢንተርናሽናል አማካሪ መሃንዲሶች

Consultation Meeting With Wereda Offices
(ከወረዳ ጽ/ቤት ጋር የተደረገ ምክክር)

Minutes of the Discussions (የስብሰባው ቃለ-ጉባኤ)

የጊቤ III [illegible]

[illegible] (flood) [illegible]

[illegible] (flood) [illegible] (flood) [illegible]

[illegible]

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Consultation Meeting With Wereda Offices
(ከወረዳ ጽ/ቤት ጋር የተደረገ ምክክር)

Minutes of the Discussions (የስብሰባው ቃለ-ጉባኤ)

[illegible] (flood) [illegible]

1. [illegible] (flood) [illegible]
2. [illegible]
3. [illegible] (flood) [illegible]
4. [illegible]

[illegible]

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Consultation Meeting With Communities (ከህብረተሰቡ ጋር የተደረገ ምክክር)

Point of Discussion: (የውውይት ርእስ) [illegible]

Place of the Meeting (ውውይት የተደረገበት ቦታ) [illegible]

Date (ቀን) [illegible]

Time (ሰዓት) [illegible]

Ser. No. (ተ.ቁ)	Name of the Participant (የተሳታፊው ስም)	Wereda (ወረዳ)	PA (የቀበሌ ገበሬ ማህበር)	Village (መንደር)	Position (በቀበሌ ገበሬ ማህበር ውስጥ ያለው ኃላፊነት)	Signature (ፊርማ)
1	[illegible]	[illegible]	[illegible]		[illegible]	
2	[illegible]	[illegible]	[illegible]		[illegible]	
3	[illegible]		[illegible]		[illegible]	
4	[illegible]	[illegible]	[illegible]		[illegible]	
5	[illegible]	[illegible]	[illegible]		[illegible]	
6	[illegible]	[illegible]	[illegible]		[illegible]	
7	[illegible]		[illegible]		[illegible]	
8	[illegible]		[illegible]		[illegible]	
9						
10						

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Consultation Meeting With Communities (ከህብረተሰቡ ጋር የተደረገ ምክክር)

Points of the Discussions (በውይይቱ የተነሱ ነጥቦች)

[illegible]

2. [illegible]

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Consultation Meeting With Communities
(ከህብረተሰቡ ጋር የተደረገ ምክክር)

Points of the Discussions (በስብሰባው የተነሱ ነጥቦች)

3. [illegible]

4. [illegible]

[illegible]

1. [illegible]
2. [illegible]

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Mid-Day International Consulting Engineers ሚድ-ዴይ ኢንተርናሽናል አማካሪ መሃንዲሶች

Consultation Meeting With Communities
(ከህብረተሰቡ ጋር የተደረገ ምክክር)

Points of the Discussions (በስብሰባው የተነሱ ነጥቦች)

3. [illegible]

4. [illegible]

[illegible] (flood) [illegible]

ሀ. [illegible]
ለ. [illegible]
ሐ. [illegible]

Mid-Day International Consulting Engineers

Mid-Day International Consulting Engineers ሚድ-ዴይ ኢንተርናሽናል አማካሪ መሃንዲሶች

Consultation Meeting With Wereda Offices (ከወረዳ ጽ/ቤት ጋር የተደረገ ምክክር)

Point of Discussion: (የውውይት አርእስ) [illegible] (flood)

Wereda (የወረዳው ስም): ዳሰነች (Dasenech)

Place of the Meeting (ውውይት የተደረገበት ቦታ): [illegible] (office of administration).

Date (ቀን): 30-3-2000 (10-12-07).

Time (ሰዓት): 5:20 (11:10)

Ser. No. (ተ.ቁ)	Name (የተሳታፊው ስም)	Position (ኃላፊነት)	Telephone/Fax/Email (ስ.ቁ/ፋክስ/ኢሜል)	Signature (ፊርማ)
1	Girma Gnewaryn	Dasenech worda Ad.	T 0911915892	
2	Kebede Sahile	Deputy Administrator	0916869513	
3	Wondwosen Loselimoy	Dasenech Worda council Main Speaker	0916 856420	
4	Mintarfew Addisu	head of education office	0461151557	
5	Ekayo Lokabel	Judicy security office		
6	MERGA AYANA	Public Relation and political		
7	TESFAYE WUBNEH	Fishery Expert		
8	Mesfin Alemu	Livestock Expert		
9	STEFANO VEROCCHIA	SOCIO-ECONOMIST expert		
10	Domenico Fino	IRRIGATION ENGINEER		

Mid-Day International Consulting Engineers ሚድ-ዴይ ኢንተርናሽናል አማካሪ መሃንዲሶች

Consultation Meeting With Wereda Offices (ከወረዳ ጽ/ቤት ጋር የተደረገ ምክክር)

Point of Discussion: (የውውይት አርእስ)

Wereda (የወረዳው ስም):

Place of the Meeting (ውውይት የተደረገበት ቦታ):

Date (ቀን):

Time (ሰዓት):

Ser. No. (ተ.ቁ)	Name (የተሳታፊው ስም)	Position (ኃላፊነት)	Telephone/Fax/Email (ስ.ቁ/ፋክስ/ኢሜል)	Signature (ፊርማ)
11	ALESSANDRO CACCIARINI	PHOTOINTERPRETER GEOLOGIST	0039 015 242150	
12	DEMEKEW DAGNE	Anthropologist	011 660 46 66	
13	Lalefo Sadore	Fishery expert		
14	Tamirat Aemro	Head of Agriculture		
15	Yitayesu Belachew	Head of water resource		
16	Bizuayehu Beyene	Head of woreda Health office		
17	Habtamu Denbeba	Sinor Economist		
18	Dejene Woldemariam	Environmentalist	091[illegible]	
19	HECTOR MCKILLICAN	AGRONOMIST		
20	LUCA FERRUZZI	NATURAL RESOURCES	0039-3282294964	
21	Newon Beyabil	Deputy head finance & Economic	Newbeyabil@ yahoo.com 0916832157	

Mid-Day International Consulting Engineers ሚድ-ዴይ ኢንተርናሽናል አማካሪ መሃንዲሶች

Consultation Meeting With Wereda Offices
(ከወረዳ ጽ/ቤት ጋር የተደረገ ምክክር)

Minutes of the Discussions (የስብሰባው ቃለ-ጉባኤ)

የጊቤ ሶስት [illegible] (GG-III Hydroelectric Project, Environmental Impact Assessment, Downstream Impact Study) [illegible] (flood) [illegible]

[illegible]

1. [illegible]

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Consultation Meeting With Wereda Offices
(ከወረዳ ጽ/ቤት ጋር የተደረገ ምክክር)

Minutes of the Discussions (የስብሰባው ቃለ-ጉባኤ)

[illegible] 6000 [illegible]

2. [illegible] (flood) [illegible]

3. [illegible]

4. [illegible]

5. [illegible]

[illegible]

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Consultation Meeting With Wereda Offices
(ከወረዳ ጽ/ቤት ጋር የተደረገ ምክክር)

Minutes of the Discussions (የስብሰባው ቃለ-ጉባኤ)

[illegible]

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Mid-Day International Consulting Engineers — Gibe III Hydropower Project, Environmental Impact Assessment

Environmental Impact Assessment (2007)

Wereda Introduction Meetings

(Under the responsibility of MDI)

Zone:- South Omo
Wereda:- Dasenech
3/9/99

Participants

No.	Name	Profession/Position	Tel/Fax/E-mail	Signature
1	Girma Gewerya	Wereda Ad.	0467750403	
2	DANIEL TAMRAT	Wereda Ministry Head		
3	Mekeb Aderwa	wored finace office head		
4	Mindefue Adisu	" edue office head		
5	Mesfeleh Zegeye	Women offices head		
6	Lesiye Ergado	Head of Justice and security office		
7	Beley Meteku	Head of Agri. Office		
8	Kebede Salile	Head of Bui. Capacity		
9	Mulukassa Shifaw	Vice A. dm of Agri.		

Mid-Day International Consulting Engineers

Mid-Day International Consulting Engineers — Gibe III Hydropower Project — Environmental Impact Assessment

Environmental Impact Assessment (2007)

Werada Introduction Meetings

(Under the responsibility of MDI)

Remarks / Notes

ማስታወሻ:

[illegible]

Mid-Day International Consulting Engineers — Gibe III Hydropower Project — Environmental Impact Assessment

Environmental Impact Assessment (2007)

Zone Introduction Meetings

(Under the responsibility of MDI)

Remarks / Notes

ማስታወሻ:

[illegible]

Mid-Day International Consulting Engineers ማይ-ዴይ ኢንተርናሽናል አማካሪ መሃንዲሶች

Consultation Meeting With Communities (ከህብረተሰቡ ጋር የተደረገ ምክክር)

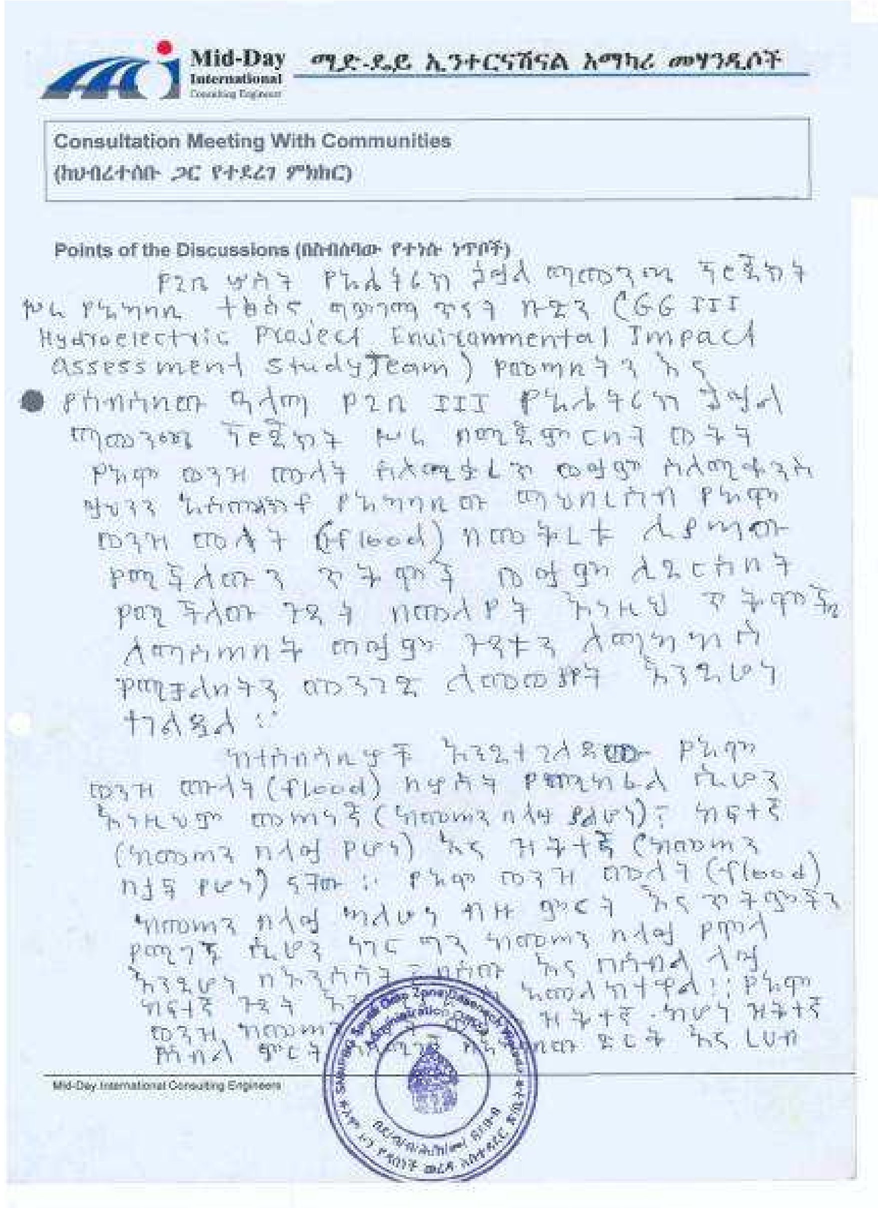
Point of Discussion:

Place of the Meeting:

Date:

Time:

Ser No.	Name of the Participant	Wereda	PA	Village	Position	Signature



Mid-Day International Consulting Engineers ማይ-ዴይ ኢንተርናሽናል አማካሪ መሃንዲሶች

Consultation Meeting With Communities (ከህብረተሰቡ ጋር የተደረገ ምክክር)

Points of the Discussions (በስብሰባው የተነሱ ነጥቦች)

(GG III Hydroelectric Project Environmental Impact Assessment Study Team)

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Consultation Meeting With Communities
(ከህብረተሰቡ ጋር የተደረገ ምክክር)

Points of the Discussions (በስብሰባው የተነሱ ነጥቦች)

እንደሚከተለው ተገልጿል ::

[illegible] (flood) [illegible]

[illegible]

[illegible] (flood) [illegible]

1. [illegible]

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Mid-Day International Consulting Engineers ሚድ-ዴይ ኢንተርናሽናል አማካሪ መሃንዲሶች

Consultation Meeting With Communities
(ከህብረተሰቡ ጋር የተደረገ ምክክር)

Points of the Discussions (በስብሰባው የተነሱ ነጥቦች)

2. [illegible] (flood) [illegible] (flood) [illegible] (flood) [illegible]

3. [illegible]

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Consultation Meeting With Communities
(ከህብረተሰቡ ጋር የተደረገ ምክክር)

Points of the Discussions (በስብሰባው የተነሱ ነጥቦች)

[illegible]

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Mid-Day International Consulting Engineers ሚድ-ዴይ ኢንተርናሽናል አማካሪ መሃንዲሶች

Consultation Meeting With Communities
(ከህብረተሰቡ ጋር የተደረገ ምክክር)

Points of the Discussions (በስብሰባው የተነሱ ነጥቦች)

[illegible]

Mid-Day International Consulting Engineers

Mid-Day International Consulting Engineers ሚድ-ዴይ ኢንተርናሽናል አማካሪ መሃንዲሶች

Consultation Meeting With Wereda Offices (ከወረዳ ጽ/ቤት ጋር የተደረገ ምክክር)

Point of Discussion: (የውይይት አርዕስት)
Wereda: (የወረዳው ስም)
Place of the Meeting (የውይይቱ ቦታ)
Date (ቀን) 5/04/2000
Time (ሰዓት)

Ser. No. (ተ.ቁ)	Name (የተሳታፊው ስም)	Position (ኃላፊነት)	Telephone/Fax/Email (ስልክ/ፋክስ/ኢሜል)	Signature (ፊርማ)
1	[illegible]	[illegible]	–	[signature]
2	[illegible]	[illegible]	–	[signature]
3	[illegible]	[illegible]	–	[signature]
4	[illegible]	[illegible]	–	[signature]
5	[illegible]	[illegible]	–	[signature]
6	[illegible]	[illegible]	–	[signature]
7	[illegible]	[illegible]	–	[signature]
8	[illegible]	[illegible]		[signature]
9	[illegible]	[illegible]		[signature]

Mid-Day International Consulting Engineers ሚድ-ዴይ ኢንተርናሽናል አማካሪ መሃንዲሶች

Consultation Meeting With Wereda Offices
(ከወረዳ ጽ/ቤት ጋር የተደረገ ምክክር)

Minutes of the Discussions (የስብሰባው ቃለጉባኤ)

[illegible]

1. [illegible]
2. [illegible]
3. [illegible]

Mid-Day International Consulting Engineers

Mid-Day International — ሚድ-ዴይ ኢንተርናሽናል አማካሪ መሃንዲሶች

Consultation Meeting With Wereda Offices
(ከወረዳ ጽ/ቤት ጋር የተደረገ ምክክር)

Minutes of the Discussions (የስብሰባው ቃለጉባኤ)

4. የአካባቢው ኢንቨስተሮች በተለይ የካሣ ማካካሻ
ጥናቱ በማስ ላይ እንዲደረግ ወይም የካሣ
ማካካሻ ጉዳይ የተመለከተው በአግባቡ ወጥቶ
ለሌ ላይው ማለት ይቻላል።

እርሻ ልማት በአብዛኛው ሀብት የሚያመርቱ ሲሆን
ለሀገር በጣም ጠቃሚ በመሆኑ ቢሆን ሰራተኛ
ይገባ ባለ የሰራ ... እርሻ በመጠቀም ነው።

የኢንቨስትመንት ፋብሪካ ሀብት ግንባታ ስለሆነ
የሰፋ ጉዳይ ለእርሻ ልማቱ የሚወሰን ጉዳይ ነው።
ስለሆነም ይህ ጉዳይ ሊታሰብበት ይገባል ተብሏል።

በአካባቢው የመሬት ችግር ማስከፈት፤
የተገለፀ የአርብቶ አደሮች እና የልማት እርሻ
ማስተካከል ለማግኘት ልዩ ሊሆን
እንዲደረግ ከተሰብሳቢዎቹ ተገልጿል።

Mid-Day International Consulting Engineers

Appendix 9: Person Contacted and Institutions Visited

Sr.No	Persons Contacted	Organization	Responsibility
Federal Offices			
1	Ato Berhanu Tadesse	Authority for Research and Conservation of Cultural Heritage	Prehistorical Archaeology Expert
2	Ato Mesele Fishea	Basin Development studies Dep't Ministry of Water Resource	Head of the Department
3	Ato Solomon Kebede	Environmental Protection Authority	Head Environmental Impact Assessment Service
4	Ato Yeneneh Teka	Ministry of Agriculture and Rural Development (Wildlife Conservation Department)	Senior Wildlife Expert
Regional Offices			
Male Wereda, SouthOmo Zone			
5	Ato Kaydaki Gezahegne	Zone Administration	Zone Administrator
6	Ato mohamed Mekonen	Zonal Agri/Ru/Devt. office	Representative of Zonal Agri/Ru/Devt. office
7	Ato Endeshaw Mamo	Zonal Agri/Ru/Devt. office	Representative, Zonal Agricultural Desk
8	Ato Seifu Lemma	Zonal Agri/Ru/Devt. office	Animal and Fishery Expert
9	Ato Meseret	Mago National Park	Head, Mago National Park
10	Ato Samule Taye	Omo National Park	Administration and Finance Coordination
Hammer Wereda, SouthOmo Zone			
11	Ato Tsegaye Alefa	Wereda Administration	Wereda Administrator
12	Ato Andualem Lala	Agri/Ru/Devt. office	Agri/Ru/Devet.Office Deputy Head
13	Ato Wondeferaw Kala	Wereda Administration	Wereda Deputy Administrator
14	Ato Emenet Gashawe	Youth and Sport Office	Youth and Sport Office Head
15	Ato Shewli Ayke	Agri/Ru/Devt. office	Agri/Ru/Devet.Office Head
16	Ato Lale Biwa	Education Office	Head, Education Office
17	Ato Tamirat Gezahegne	Finance And Economic Devt.Office	Head,Finance And Economic Devt.Office
18	Ato Aregore Ekoda	Wereda Administration	V/Administrator
19	Ato Abreham Ayele	Water Resources Dev't office	Water Resources Dev't office Representative
20	Ato Adja lema	Werda Administration	Main Speaker
21	Ato Simenehe Gezahegn	Werda Administration	Deupty Head, Wereda Administration office
22	Ato Walle Adma	Werda Administration	Wereda administration Office Delegate
23	Ato Habue Meggu	Werda Administration	Wereda administration Office Delegate
24	Ato Taye Lowoyo	Werda Administration	Wereda Council Member
25	Ato Ariyo Dore	Werda Administration	Head of Public Relation
26	Ato Israel Adane	Agri/Ru/Devt. office	Section Head
27	Ato Gino Kosho	Werda Administration	Information Head
28	Ato Ewnetu Zewede	Wereda Capacity Building Office	Head of Capacity Building Office
29	Ato Feleke Seyoum	Wereda Administration	Public Relation officer

Sr.No	Persons Contacted	Organization	Responsibility
30	Ato Lubuko Zuno	Karaduse PA	Member of Council
31	Ato Dembi Meda	Karaduse PA	Health Extension Worker
32	Ato Ali Pala	Karaduse PA	Agricultural Extension Worker
33	Ato Ayeke Muncha	Karaduse PA	Agro Pastoralist
34	Ato Halecha Areti	Karaduse PA	Member of PA
35	Ato Para Beleko	Karakorecho PA	Chairman
36	Ato Arbalo Luwayo	Karakorecho PA	Public Relation
37	Ato Sere Lepelo	Karakorecho PA	Justice and Security
38	Ato Lema Damo	Karakorecho PA	Agro Pastoralist
39	Ato Petros Lema	Karakorecho PA	Agro Pastoralist
40	Ato Nanga Kwa	Karakorecho PA	Information Worker
Dasenech Wereda, SouthOmo Zone			
41	Ato Girmia Gneweriya	Dasenech Wereda	Wereda Administrator
42	W/O Meselech Meteki	Finance And Economic Devt.Office	Head, Finance And Economic Devt.Office
43	Ato Minlargew addisu	Education Office	Head, Education Office
44	W/O Meselech Zegeye	Womens Affairs Office	Head, Women's Affairs Office
45	Ato Daniel Tamirat	Health Office	Head, Health Office
46	Ato Neway Bezabihe	Finance and Economy Office	Head, Finance and Economy Office
47	Ato Tamirat Aemero	Wereda Agricultural Office	Head Of Wereda Agricultural Office
48	Ato Loyisa Ergudo	Justice and Security Office	Justice and Security Office
49	Ato Belay Metekiu	Agri/Ru/Devt. office	Head, Agri/Ru/Devt. office
50	Ato Kebede Sahile	Wereda Administration Office	Deupty Administrator
51	Ato Mulukasa Shiferaw	Agri/Ru/Devt. office	Vice Head, Agri/Ru/Devt. office
52	Ato Akurekare Lukareya	Rate Peseant Association	Chairman, Peasant Association
53	AtoWondwossen Losilmay	Administration Office	Council main speaker
54	Ato Bizuayehu Beyene	Health office	Head, Health Office
55	Ato Ekayo Lokabel	Administration Office	Deputy head Justice and Security Office
56	Ato Merga Ayana	Administration Office	Public relation and political officer
57	W/ro Era Mere	Peasant Association Lobet PA	Women Association Chairman
58	Ato Ekreya Loluk	Peasant Association Lobet PA	Chairman
Nyangatom Wereda, SouthOmo Zone			
59	Ato Tefera Naskie	Wereda Administration	Deputy Wereda Administrator
60	Ato Tadele Fikadu	Agri/Ru/Devt. office	Head, Agri/Ru/Devt. office
61	Ato Guyola Olata	Finance and Economic Devt.Office	Head,Finance and Economic Devt.Office
62	Ato Demek Geteso	Agri/Ru/Devet.Office	Agri/Ru/Devet.Office Deputy Head
63	Ato Afework Abaye	Finance And Economic Devt.Office	Head,Finance And Economic Devt.Office
64	Ato Eyasu Lobarawye	Justice and Security Office	Justice and Security Office
65	Ato Lukngamo Merem	Wereda Administration	Head, Information Office
66	Ato Tadele Fekadu	Agri/Ru/Devet.Office	Head, Agri/Ru/Devet.Office

Sr.No	Persons Contacted	Organization	Responsibility
67	W/ro Watet Tekele	Wereda Women's Affairs Office	Deputy Head, Wereda Women's Affairs Office
68	Ato Melkamu Zewede	Capacity Building Office	Deputy Head, Capacity Building Office
69	W/ro Hana Ejamo	Wereda Women's Affairs Office	Head, Wereda Women's Affairs Office
70	Ato Kabeto Abune	Wereda Administration Office	Head of administration Office
71	W/o Mekdes Lojiko	Culture and Information office	Deputy Head, Culture and Information Office
72	Kassaye Mokereya	Wereda Police Office	Police Officer
73	Ato Hiwas Ale	Peasant Association Lupakor	Kebele Administrator
74	Ato Lame Mubetero	Peasant Association Ayepa	Health Extension
75	Ato Losese Murale	Peasant Association Lorengkachal	Chairman of Kebele
76	Ato Hekurur Aseru	Peasant Association Natekar	Police
77	Ato Kotol Ayele	Peasant Association Naktekar	Health Extension
78	Ato Hepeko Hekerma	Peasant Association Shenkora	Administrator
79	Ato Muhu Hekoto	Peasant Association Kucheru	Pastoralist
80	Ato Buno Dabo	Peasant Association Kucheru	Student
81	Ato Edeme Hekem	Peasant Association Narowaye	Security Guard
82	Ato Lokrewye Nasal	Peasant Association Shenkora	Chairman of Kebele
Selamago Wereda, South Omo Zone			
83	Ato Melkamu Engida	Wereda office	Wereda Administrator
84	Ato Esubalew Tesfaye	Agri/Ru/Devet.Office	Agri/Ru/Devet.Office Deputy Head
85	Ato Hegu Ketatu	Wereda office	Main Speaker
86	Ato Chanyalew Yitebarek	Head, Education Office	Head, Education Office
87	Ato Bezuayehu Geremew	Wereda office	Public Relation Affairs Head
88	Ato Agu Deban Geso	Agri/Ru/Devet.Office	Agri/Ru/Devet.Office Deputy Head
89	W/o Ababa Seftaye	Women's Affairs Office	Head, Women's Affairs Office
90	Ato Berhanu Aragaw	Capacity Building Office	Capacity Building Office Head
91	Ato Yeredaw Ashene	Capacity Building Office	Capacity Building Office D/Head
92	Ato Betongeya Molognmer	Hayleweha PA	Chairman, Peasant Association
93	Ato Gunazeg Gelbush	PA Omo Hana	Agro Pastoralist
94	Ato Mako Aychekam	Gura PA	Kebele V/Administrator
95	Ato Luchnga Kenshema	Gura PA	Agro Pastoralist
96	Ato Arebu Luluma	Gura PA	Pastoralist
Non Governemntal Organizations			
97	Ato shigute Bifesse	Omo Valley Agro Industry PLC	Expert
98	Dr. Tadesse Mesfen	Farm Africa	Advisor
99	Ato ahmed Jemal	Farm africa	Agricultural Expert
100	Ato Samule Taye	Omo National Park	Adm. and Finance Coordination

Appendix 10: Consultant Team

The experts that contributed to this Additional Study on Downstream Imapcts are as listed below:

Team Member	Position/Profession	Qualification
AGRICONSULTING		
Domenico Fino	Water Resources and Irrigation Engineer/International Co-ordinator	Doctorate Degree Irrigation Engineering
Luca Ferruzzi	Terrestrial and Aquatic Ecology, Conservation of Natural Resources, Cultural Heritage/ Assistant Team Co-ordinator	Doctorate Degree Forest Sciences
Hector McKilligan	Irrigated Crop and Fodder Production, Commercial Agriculture Development	MSc Tropical Agricultural Crops
Stefano Verdecchia	Social Management and Cooperatives, Market Socio-economy/ Community Development	Doctorate Degree Political Sciences
Alessandro Cacciarini	Geomorphology / Remote Sensing Expert	Doctorate Degree Geology
MDI CONSULTING ENGINEERS		
Dejene Woldemariam	National Coordinator/EIA Expert	BE, MTech
Mesfin Alemu	Livestock Expert	BSc MSc
Tesfaye Wudneh (Dr)	Fishery Expert	BSc MSc PhD
Laluto Sadore	Fishery Expert	MSc
Bedilu Amare	Agriculturalist/ Environmentalist	BSc MSc
Habtamu Denboba	Community Mobilisation Experts	BA MA
Temsegen Yimer	Sociologist/Gender Specialist	BA
Demirew Dagne	Anthropologist / Cultural Heritage	BA MA
Belay Seyoum	GIS/Remote Sensing Expert	BSc MSc