EMERGENCY COMMUNITY-BASED RECHARGE
INTERVENTIONS FOR THE RESTORATION OF LAKE JIPE

BASELINE SURVEY REPORT FOR LAKE JIPE

Supported by EU - BCP/CDTF Programme

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EXECUTIVE SUMMARY

This study was commissioned by Committee of the Organization for Volunteering Services (COSV) an international non-governmental organization as the implementing agency for the Biodiversity Conservation Programme; Community Development Trust Fund BCP/CDTF Lake Jipe Restoration Project. The purpose of the study was to collect baseline/background information-Biophysical, socio-cultural and economical on Lake Jipe ecosystem including the River Lumi flood plains, identify anthropogenic activities that pose adverse impacts on the environment, assess, analyze and evaluate the impacts of the identified activities on the Lake Jipe ecosystem and finally develop a Land Use Plan and an Environmental Management Plan (EMP) to mitigate, and monitor the negative impacts.

Lake Jipe is an important transboundary wetland ecosystem stretching across the Kenya and Tanzania boarder; important to the local communities who use it for fisheries, domestic water supply, and livestock watering and as part of renowned Tsavo West National Park, where diverse biodiversity of (Avi-fauna), fish, amphibians, reptiles, huge mammals and wetland plants are found. This ecosystem has a complex hydrological system transcending to both Kenya and Tanzania linked to Mt. Kilimanjaro and the Pare Mountains, which form part of the Eastern Arc Mountains.

This study has established the status and trends of the natural resources found in the area as well as the impending threats including the influencing factors of the threats. The study has also established the nature of the human activities in the area, the anthropogenic impacts, existing resource tenure systems, and opportunities for addressing the adverse impacts identified.

Among the issues highlighted as resulting in the degraded state of the wetland include overgrazing around the lake basin, cultivation on the riverbanks, increased soil erosion and the continuous siltation of the Lumi River, infestation of the Lake by the typha weeds, deforestation, and diversion of the River. Also identified is the uncontrolled creation of diversion canals in the irrigation schemes to support irrigation of crops.

The study identified and evaluated potential adverse impacts and benefits of the proposed project intervention on the environment. These include,

Beneficial Impacts

- Increased lake water flow
- Stabilization of the Lake ecosystem
- Reduced Resource Over-exploitation
- Restoration of the fishing industry
- Abating Unsustainable Land use Practices
- Increased Surface Flow Reduction

Adverse Impacts

- Population Influx
- Short term impact on water down stream due to repair of the dykes
- Over harvesting of fisheries in the lake due to improved capacity in terms of fishing gear
- Decline in crop production due to reestablishing the natural river channel

- Introduction of new tree species
- Reduction in flood plain leading to reduced grazing land
- Livestock wildlife conflict

The following mitigation measures were developed and considered feasible for the management of the potential adverse impacts of the intervention. They include;

- Use of indigenous tree species in afforestation
- Change in land tenure system
- Awareness creation in sustainable use of natural resources
- Instituting a Transboundary Management Plan for the Lake Jipe Ecosystem - Kenya-Tanzania
- Regulating water abstraction
- Controlling Fishing in the lake to protect fisheries from over exploitation
- Promoting zero grazing and destocking through marketing of livestock
- Promote improved livestock breeding to improve productivity hence need to raise few animals

The proposed mitigation measures are further outlined in the Environmental Management Plan (EMP) and further detailed in the developed Land Use Plan. It includes diligently monitoring the important parameters for the environment, which in turn will indicate whether the activities are adversely affecting the environment.

The study identified the following priority areas of concern that need to be addressed through instituting a comprehensive Environmental Management Plan and a Community based Land Use Plan for the Lake Jipe Catchment

- Riparian reserve demarcation and management
- Soil protection to avert erosion
- Irrigation and water abstraction control
- Proper canal construction and maintenance
- Harmonization and integration of cross-border wetland management
- De-Siltation and water quality monitoring
- Reforestation and Afforestation of the catchment areas
- Reinforcement of river and canal banks
- Zoning the land to accommodate compatible land uses

The issues mentioned above form the core of management actions that are required to strengthen and ensure the sustainable implementation of the project. It is imperative that a coordinated approach involving all stakeholders in Kenya and Tanzania should be sought to ensure a sustainable management framework. Similarly, the relevant legislations and policies should be enforced to minimize illegal encroachments, misuse, mismanagement and degradation of the wetland and the entire ecosystem.

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ACTS	African Centre for Technology Studies
ASALS	Arid and Semi Arid Lands
BCP	The Biodiversity Conservation Programme
CBD	Conservation on Biological Diversity
CBOs	Community Based Organisations
CDA	Coast Development Authority
CDTF	Community Development Trust Fund
CITES	Convention on International Trade in Endangered Species
CMS	Convention on Migratory Species (Bonn, Convention)
COSV	Committee of the Organization for Volunteering Services
DAEO	Divisional Area Education Officer
DDC	District Development Committee
DFO	District Forestry Officer
DO	District Officer
EAC	East Africa Community
EAWLS	East African Wildlife Society
ECF	East Coast Fever
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
ESF	Environmentalistes Sans Frontiéres
EU	European Union
GIS	Geographical Information System
GoK	Government of Kenya
GTZ	German Technical Cooperation
IUCN	International Union for Conservation of Nature
IWRB	International Waterfowl Research Bureau
KARI	Kenya Agricultural Research Institute
KONAM	Kenyan Organization Facilitating Active Community Development Methodologies
KWS	Kenya Wildlife Service
MWRD&M	Ministry of Water Resources Development and Management
NEMA	National Environment Management Authority
NGOs	Non Governmental Organizations
PIC	Project Implementation Committee
SGP	Small Grants Programme
UNDP	United Nations Development Programme

1 INTRODUCTION

The Lake Jipe ecosystem, which includes the Lake and associated wetlands, is located southeast of Mt. Kilimanjaro and is considered an international water body straddling along the Kenya-Tanzania border. The Lake had been undergoing rapid and unprecedented decrease in water levels, massive siltation and increased emergence of water weeds (*typha spp*) – almost to a point of disappearance.

Lake Jipe is approximately 10kms long and 3km wide with its main catchment area consisting of Mt. Kilimanjaro and the Pare Mountains both in Tanzania. Lake Jipe is a significant natural resource that plays a significant role in providing resources and vital services to the population and wild flora and fauna that are located around it. For a very long time the Lake Jipe has provided fertile fishing grounds for the communities round it, water for domestic and agricultural use. Key services including habitat provision for extensive flora and fauna, and maintenance of the hydro-geological cycle and regulation of the local climatic conditions.

However, in the recent past there has been marked degradation and deterioration of this vital resource through indiscriminate human activities. This has not only threatened the lake, it is indicated to be slowly contributing to the extinction of the entire Lake. Indeed there has been alarm shown and raised by different conservation organisations and scientists that Lake Jipe is disappearing. These organisations include among others The East African Wildlife Society (EAWLS), United Nations Development Programme (UNDP), United Nations Environment Programme (UNEP). Poor wetland and land management at and around the lake had greatly destabilised the wetland leading almost to its eventual demise.

The Biodiversity Conservation Programme (BCP) of the community Development Trust Fund (CDTF), a European Union/ Gok partnership program aimed at supporting community biodiversity conservation initiatives in Kenya provided funding aimed towards the restoration and the reversal of the deteriorating nature of the Lake.

Through the assistance from the European Union – Biodiversity Conservation Programme [BCP] (Community Development Trust Fund [CDTF]) restoration of Lake Jipe ecosystem was initialized in 2004 to salvage it from eminent deterioration. COSV–an Italian international humanitarian and development NGO together with KONAM – a local NGO, mobilized the local communities in undertaking restoration activities for the lake. The activities were mainly geared towards:

- Re-establishing the natural channels of River Lumi with the objective of re-establishing the natural course of River Lumi and enhance flow of water into Lake Jipe.
- Minimizing crop destruction, loss of human life and destruction of property by wildlife along rivers Lumi and Ruvu.
- Alleviating poverty and improve local community's food security.
- Increasing on-farm vegetation cover on the small-scale farms along River Lumi through afforestation and agro-forestry,
- Enhancing availability of and accessibility to freshwater through extension of the existing supply system from Mata village to Kilomita Saba village,

- Enhancing sustainable fishing practices and to stimulate the formation of an effective multi-sectoral/ institutional structure through which long term conservation of Lake Jipe can be addressed (Lake Jipe Conservation Forum).

The project implementation was coordinated and supervised by a multi- sectoral/ stakeholder committee comprising the committee of the Organizations for Volunteering Services (COSV), the East African Wildlife Society (EAWLS), National Environment Management Authority (NEMA), Kenyan Organization Facilitating Active Community Development Methodologies (KONAM), Kenya Wildlife Service (KWS), Ministry of Water Resources Development and Management (MWRD&M), and representatives of the local community.

The overall goal of the proposed project was **"to recharge the rapidly drying Lake Jipe and improve the livelihoods of the adjacent communities"**, with the broad goal of enhancing the conservation of an important transboundary wetland ecosystem in Kenya and Tanzania through;

- Manually de-silting the natural Lumi River course over a distance of approximately 5 Km,
- Repairing damaged dykes along the natural river course,
- Organizing a series of community-based workshops to sensitize the stakeholders on the need to adopt best conservation practices particularly along River Lumi and around its key sources (natural springs),
- Provide clean and fresh water to Jipe location residents through the extension of piped water from Mata village to Kilomita Saba village,
- Establishing three community-based tree nurseries and support fishing activities (purchase of canoes, fishing nets, fishermen capacity building etc.)

The effective implementation of this project was anticipated to lead to several project outputs in diverse and interrelated fronts namely;

1.2 Biodiversity Conservation

1. Protection of important wildlife species like the elephant, hippos, crocodiles, birds and fishes. The Lake is also a home to water birds among them being the lesser Jacana, the purple gallinule, the Madagascar squaco heron, the black heron, African darter and the African skimmers. Key fish species include the endemic tilapia *(Oreochromis jipe),* mudfish (Clarias *mossambicas*), among others.
2. Sustenance of ecological integrity of Lake Jipe hence enhance ecological services provision.
3. Enhanced on farm tree species diversification. Proposed species to be encouraged include high value or improved mango and citrus. Fast growing species popular with the farmers in the area, e.g. *Melia volkensiii*, and casuriana, soil stabilization grasses to be planted along the river banks, e.g. Bamboos and rattans and fast growing fodder/fuel wood tree species including *Cassia siamia, C spectabilis and Azadiracta indica.*

1.3 Economic Benefits

1. Increased fish yields tending to the levels of 1996 estimated at 5-6 tons per month,
2. Increased income from tourism based activities,

3. Reduced crop destruction from wildlife invasions,
4. Release of labour meant to fetch water for other economic activities, and
5. Reduced cost of crop and property damage due to flooding

1.4 Social impacts

2. Improved health,
3. Higher purchasing power, and
4. Involvement in social activities

ESF Consultants an Environmental Management firm was contracted to assess the environmental effects of implementing the proposed project activities for intervention on Lake Jipe ecosystem and design an Environmental Management Plan and Land Use Plan for the Lake ecosystem. At the time of undertaking this study, the re-establishment of the river channel had already been undertaken and water levels were gradually increasing. The main objective of an Environmental Impact Assessment at this point was to establish the impacts of these activities and recommend appropriate strategies towards long-term sustenance of the ecosystem as a whole.

2 STUDY METHODOLOGY

A variety of methodologies and tools were used to help collect, identify, assess, evaluate, analyze and predict the situations and impacts of the proposed project activities based on the scope of the project and area of influence.

3.1 Study Scope

The scope of this study coverered Lake Jipe ecosystem including River Lumi and Ruvu. The spatial area includes Lake Jipe wetland ecosystem stretching across the Kenya boarder, the local communities who use it for fisheries, floodplain ecosystem, domestic water supply, livestock watering and also biodiversity conservation area, part of Tsavo West National Park, where diverse biodiversity like species of water birds, fish, amphibians, reptiles and wetland plants are found. The scope will include the drainage basin in Kenya and Tanzania linking to Mt. Kilimanjaro and the Pare Mountains.

3.2 Methodologies for Baseline data Collection

The baseline study was conducted during the scoping exercise and more information gathered during the EIA process. Data and information was gathered through participatory approaches based on the following steps,

- Review of relevant literature
- Field reconnaissance and data gathering
- Various stakeholder group meetings and discussions
- Data synthesis and analysis

Interviews with the various stakeholders followed a pre-arranged open-ended structured questions based on the ToR.

3.2 Secondary Data Collection Methods

3.3 Literature Review

The consultants reviewed literature from different sources on Lake Jipe and Taveta Sub district as a whole. A lot of materials have been published on Lake Jipe both from the Kenyan and Tanzanian side. Research papers from IUCN-World Conservation Union, the Ministry of Water and Environment publications, Kenya Agricultural Research Institute (KARI) materials and EAWLS were a rich source of background information on the study area.

3.4 Primary Data Collection Methods

3.5 Transect Walks

Transects were laid to get detailed information about the different land use activities. The objective of this method was to cover all major agro-ecological and production zones and ensure representation of topographical, resource and socio-economic differences of communities. Transect walks were carried out in Taveta sub-district which represents the Jipe catchment.

To get a complete view of the catchment, transect walks were carried on special sites of interest including irrigation schemes, water supply facilities, agricultural areas, riparian reserves and fishing

areas. Several group and community meetings were held to get a detailed view about the situation, activities and problems of the other communities.

3.6 Public Participation

There are a variety of methods of soliciting information from interested and affected parties in any given project. Consideration was given to the location of the project area and the people likely to be involved in the project. The socio-economic status and culture of the community as well as the level of organization was considered. The initial project visit coincided with the Project Implementation Committee (PIC) Meeting. During this meeting views were sought from members present. Additionally, opinions of other interested and affected people were sought including businessmen, local administration, fishermen, villagers, and hotel operators.

Some of the information that was gathered included the background of the project; alternative sources of income; reference to other interested parties that should be consulted; perceived needs and attitudes regarding the proposed project; ideas and justifications for project alternatives, concerns and perceptions; past or ongoing concerns related to the project and areas that the lead agencies could assist. A list of Interested and affected people/stakeholders who were consulted are listed in the appendix section. The Environmental Impact Assessment process also allowed for public comment and review of the proposed project both before and after the impact report had been written. This allowed for the project to capture all-important concerns of interested and affected parties.

3.7 Soil Sampling and Testing

Five soil samples were collected from the different areas of the catchment to cover all land use areas in the project area of study.

Irrigation schemes were sampled with the intention of evaluating the samples to get information about the fertility and the salinity rate of the different soil types and to compare areas with different ground watered tables (North and South of the catchment).

In general, samples of areas were taken from different depths, the topsoil (0-30cm) and deeper layer at 30 cm to 60cm. In the catchment all sites were sampled in depths 0-20 cm and 40 –60 cm to get information about possible distribution of salty minerals in the soils all analyzed samples taken at each location to reduce possible sources of errors.

The samples were analyzed at Quest Laboratories in Nairobi which is a National Environment Mangement Authority (NEMA) certified and accredited testing and anlaysis institution.

3.8 Water Sampling and Testing

Water samples were taken from various points on Lake Jipe, River Lumi, Njoro Kubwa Springs, and River Ruvu. The samples were analysed to determine the Electrical Conductivity (EC), Nitrates and Nitrites, Alkalinity and Salinity.

3.9 Methodologies for Impact Identification

The Environmental Assessment study put into use a variety of methodologies and tools in order to identify situations and impacts. The type and use of these methodologies varied with the areas of

application and required data type. In general, methodologies utilized in the study included checklists, public participation, expert opinion, use of Geographical Information Systems (GIS), direct field observations and water and soil analysis.

3.10 Methodologies for Impact Analysis

Impact analysis and evaluation adopted a number of methodologies. These included the use of impact matrix, expert opinion, Geographic Infromation Systems (GIS), desktop analysis of secondary data and network analysis. These assisted in understanding expected impacts in terms of their magnitude, extent, character and significance. Network technique was also used in impact analysis to identify indirect and cumulative impacts. They are an extension of flow charts to incorporate long-term impacts. Environmental components are usually interconnected in nature and they form networks. It's therefore important to identify secondary and tertiary impacts that are identifiable based on the project activities

4 RELEVANT POLICY, LEGISLATIVE AND REGULATORY FRAMEWORK

This section provides relevant policies, regulatory and legal statutes, which are of significance and fundamental in the implementation of this project.

Kenya has a number of laws and regulations as well as institutions that provide a key role and framework within which the implementation of certain developments must be aligned towards. These policies and legal statutes ensure that the conservation and ultimate protection of the environment remains paramount in spite of the need to promote development. This section list relevant Acts and statutes that govern the sustainable utilization conservation and management of the natural resources in Kenya and which are thus relating to the Lake Jipe ecosystem.

4.1 Environmental Management and Coordination Act (EMCA) 1999

This law is based upon the principle that everybody is entitled to a healthy and clean environment and has a duty to safeguard and enhance the environment.

The Act requires that projects likely to have significant impact get approval from NEMA before their commencement. NEMA approves and issues an environmental license after it is satisfied that there are no significant impacts of the project identified, and if there are adequate mitigation measures that have been put in place.

This is also in compliance with the requirements of the Environmental Management and Coordination Act (EMCA) Part VI section 58 (1) and (2) which states:

1) *Notwithstanding any approval, permit or license granted under this Act or any other law in force in Kenya, any person, being a proponent of a project, shall, before financing, commencing, proceeding with, carrying out, executing or conducting or causing to be financed, commenced, proceeded with, carried out, executed or conducted by another person any undertaking specified in the Second Schedule to this Act, submit a project to the authority in the prescribed form, giving the prescribed information and which shall be accompanied by the prescribed fee.*

2) *The proponent of the project shall undertake or cause to be undertaken at his own expense an environmental impact assessment study and prepare a report thereof where the Authority, being satisfied, after studying the report submitted under Subsection (1), that the intended project may or is likely to or will have a significant impact on the environment, so directs.*

The above sections are of relevance to the proposed project owing to the fact that the likelihood of the proposed interventions geared towards the restoration of Lake Jipe causing adverse impacts on the environment is unknown. Therefore, calling for the need for an EIA study that will identify and predict the adverse impacts the proposed activities might have on the environment and ensure mitigation strategies in place.

Part VIII section 72, of the Act prohibits discharging or applying poisonous, toxic, noxious or obstructing matter, radioactive or any other pollutants into aquatic environment.

Part V section 42 (Protection of river, lakes and wetlands) explicitly states that without prior written approval of the director general NEMA, given after an EA in relation to a river, lake or wetlands in Kenya carry out the following activities-

- Erect, reconstruct, place, alter, extend, remove or demolish any structure or part of any structure in, or under the river, lake or wetland.
- Excavate, drill, tunnel or disturb the river, lake or wetland.
- Direct or block any river, lake or wetland from its natural and normal course or;
- Drain any lake, river or wetland.

This section of the Act is pertinent and key to the restoration of the Lake Jipe Project, which will involve the re-establishment of natural course of river Lumi by undertaking desilting activities and construction of dykes along the course of the rivers and its banks.

Part IX section 115, of the Act states that no person/institution shall cause nuisance or conditions liable to be injurious or dangerous to human health. Section 116 requires Local Authorities to take all lawful, necessary and reasonably practicable measures to maintain their jurisdiction clean and sanitary to prevent occurrence of nuisance or condition liable to be injurious or dangerous to human health.

On the responsibility of local authorities, Part IX section 219, of the Act states that in part "it shall be the duty of every Local Authority to take all lawful, necessary and reasonably practicable measures for preventing any pollution dangerous to health or any supply of water which the public within its district has right to use for drinking or domestic purposes."

Section 30 provides for making and imposing regulations by the local authorities and others the duty of enforcing rules in respect to prohibiting use of water supply or erection of structures draining filth or noxious matter into the water supply as mentioned in section 129.

This Act and in specific the above-mentioned sections bear relevance and implication to the proposed project. This is in relation to the proposed activities, which include among others to enhance the availability of and accessibility of fresh water through the extension of the existing water system from Mata village to Kilomita Saba village. The project proponents will have to ensure that this activity is guided comprehensively by the stipulations of this Act in regard to supply and increasing accessibility to safe water for drinking.

4.2 The Wildlife (Conservation and Management) Act

This is the principal Act regulating wildlife conservation and management in Kenya. The Act establishes Kenya Wildlife Service (KWS) as the implementing agency. Under section 3A, the functions of KWS shall be among others to:

- Provide advice to the government and local authorities and landowners on the best methods of wildlife conservation and management and be the principal instrument of

government in pursuit of such ecological appraisals or controls outside urban areas as are necessary for human survival.

- The Act also authorizes the Director (KWS) to enter into agreement with other competent authorities for the purpose of ensuring that animal migration patterns essential for the continued viability of National Parks.
- Furthermore, the Minister responsible for wildlife has discretionary powers to ' promulgate such regulations to enhance the management of such protected areas, so long as the regulations so promulgated are reasonable and not *ultra vires* to the parent Act.

The Director may delegate or assign any of his functions under the Act to any officer in the service of the Forestry or Fisheries Department or to any public officer approved by the Minister (honorary warden). Other than the National Parks and Reserves, the Minister may also declare and gazette an area not exceeding two thousand, six hundred acres as a local sanctuary where extraordinary measures of protection are taken over species being nurtured for replenishment of stocks. Lake Jipe Conservation Initiative avails and created the opportunity for the application of the provisions of the Wildlife Act in furtherance of its implementation in so far as it relates to wildlife conservation and its habitat management.

4.3 The Water Act

The new Water Act (2002) of the Laws of Kenya seeks to make better provision for the conservation, control of pollution, apportionment and use of the water resources in Kenya, and for purposes they are incidental thereto and connected therewith. The Act vests ownership and control of water in the government subject to any rights of user. Under this provision the responsibility to regulate access, use and control of water resources is vested in the Water Resources Management Authority (WRMA).

This Act gives the WRMA powers to regulate access and control pollution of Lake Jipe and its supporting catchments. The WRMA should ensure the rehabilitation activities would not lead to the pollution of the lake and allow unlimited access such that it interferes with the lakes ecosystem.

The Water Act (Cap.372) lays down the basic legal framework for the management of water resources. These are all vested in the state, expect where they lie wholly within a land- owner's property. Administratively, the country is divided into six catchment areas under catchment boards that advise on allocation of water supplies. Via additional Acts, the main catchments have also been placed under specific development authorities.

The Act also gives provisions for protecting catchments from deforestation. The minister may designate protected catchment areas, within which activities may be regulated as nearly. However, the water act does not provide for control of other land uses that may degrade the catchment through soil erosion. The Agriculture Act, on the other hand, does provide a framework for dealing with these problems, although these provisions seem rarely to be implemented.

Control of water pollution is covered in a general sense by the Water Act. The legislation is deficient, since it does not lay down water quality and discharge standards or provide powers for these to be defined. It also does not provide for water quality monitoring. The Public Health and Pest Control Products Acts also touch directly or indirectly on water pollution, but there is little institutional capacity to implement their provisions.

4.4 The Agriculture Act

The Agriculture Act Cap 318 of the Laws of Kenya seeks to promote and maintain a stable and sustainable agriculture, to provide for the conservation of the soil and its fertility and to stimulate the development of agricultural land in accordance with the accepted practices of good land management and good husbandry. This Act primarily guides and regulates farming practices especially in relation to the proximity of farming within the riparian section. The Act specifies that no agricultural activity is allowed and or permitted within the riparian area of a wetland, river or Lake. The Agriculture Act is the principal land use statute covering, *inter- alia,* soil conservation, and agricultural land use in general.

It is, indeed, a crucial piece of legislation insofar as it relates to both small scale and large-scale farms within the Lake Jipe-Lumi floodplain ecosystem and catchment. One of the proposed activities for the restoration of Lake Jipe is to increase on farm vegetation cover on small-scale farms along the Lumi River through afforestation and agro-forestry development. The relevance of this section of the Act to the project is the need of the proponent to ensure that they do not farm along the riparian section of River Lumi especially beyond the allowable distances.

4.5 The Forest Act

The Forests Act, Cap 385 of the Laws of Kenya addresses reservation, protection, management, enforcement and utilisation of forests and forest resources on government land and provides for the establishment, control and regulation of Central Forests, forests and forest areas in Nairobi Area and on un-alienated Government land in Kenya. The Act, therefore, applies not only to state plantations and land controlled and managed by the Forestry Department for research purposes or for establishment of commercial timber plantations, but also areas which have been set aside for the conservation of fauna and flora, for the management of water catchment area, for the prevention of soil erosion or for the protection and management of indigenous forests on alienated Government land. This Act therefore is of extreme relevance to the proposed project. Lake Jipe and its tributaries being catchment areas require that they remain protected and preserved.

4.6 The Fisheries Act

The Fisheries Act Cap, 378 of 1989 of the Laws of Kenya provides for development, management, exploitation, utilization and conservation of fisheries and for connected purposes. The Act has been regarded as one of the most comprehensive natural resource Laws of Kenya although its implementation has remained largely wanting due low compliance levels and government capacity to implement. The Act provides the platform for promoting the development of traditional and industrial fisheries, fish culture, and related industries through extension service, research and surveys, infrastructure development, restocking, exploring marketing opportunities as well as enhancing community participation in fisheries management. The Act and the mentioned sections have a direct link to some of the proposed activities in this project. The project proposes the intention of enhancing sustainable fishing practices within the watercourses of Lake Jipe and its tributaries. To this effect, the project must ensure that there is sustainable utilization and exploitation of the fisheries in accordance with the required limits and using the appropriate type of fishing gears for fishing. Successful implementation of this Act will promote the development of traditional and industrial fisheries in Lake Jipe that at the moment are wanting.

4.7 The Land Planning Act

The Land Planning Act Cap 303 of 1968 of the Laws of Kenya makes provision for planning the use and development of land. Sec 6 (1) of the subsidiary legislation provides that *"a local authority may, after consultation with, and with the agreement of the Minister, prepare and submit to the Minister for his approval an area plan, as the case may be, for that part of the area under its jurisdiction to which these regulations apply.*" The local authority may make consultation with the minister about a plan that will give the locals land, thus enabling them participate fully and effectively on all the projects geared towards the long-term rehabilitation of an area. One of the key outputs expected from this project is the development of a land use plan for the Lake Jipe catchment. This key activity will require consultation

4.8 Physical Planning Act

This Act provides for the preparation and implementation of physical development plans for connected purposes. It establishes the responsibility for the physical planning at various levels of Government in order to remove uncertainty regarding the responsibility for regional planning. A key provision of the Act is the requirement for Environmental Impact Assessment (EIA).

It provides for a hierarchy of plans in which guidelines are laid down for the future physical development of areas referred to in a specific plan. The intention is that the three-tier order plans, the national development plan, regional development plan, and the local physical development plan should concentrate on broad policy issues.

The Act also promotes public participation in the preparation of plans and requires that in preparation of plans proper consideration be given to the potential for socio-economic development needs of the population, the existing planning and future transport needs, the physical factors which may influence orderly development in general and urbanization in particular, and the possible influence of future development upon natural environment.

Any change of use of the actual development without authority constitutes an offence. Similarly, any one who deposits refuse, scrap or waste materials in a designated area without the consent of the planning authority or the relevant local authority shall be guilty of an offence under the regulations. The general sentence under the regulations is a fine of not exceeding five thousand shillings or Imprisonment not exceeding six months, or to both, such fine and imprisonment.

This Act gives precedence for the need of undertaking an environmental impact assessment on all projects aimed at rehabilitating the lake's ecosystem, inviting public participation and taking into account possible influence of the future development upon natural environment.

4.9 Land Control Act CAP 406

This law provides for the control of transactions in agricultural land, especially the machinery of the Land Control Boards. However it is of environmental interest that one of the points to consider in granting or refusal of consent by the Board is what impact the transaction is likely to have on the maintenance or improvement of standards of good husbandry within the specific agricultural area. This may be construed to include agricultural activities beyond the carrying capacity of the land. Such a situation would constitute a basis for denying consent to a transfer or subdivision of agricultural land.

Government land is land owned by the government of Kenya under the Government Lands Act (Cap. 280). This includes, for example, gazetted national parks and reserves. The government Lands Act allows the president, through the commissioner of lands, to allocate any unalienated government land to any individual. In practice, such allocations have often been made without proper regard to social and environmental factors.

Trust land is land held and administered by various local government authorities as trustees under the constitution of Kenya and the Trust Land Act (Cap. 288). National reserves and local sanctuaries as well as County Council forest reserves, are in this category. Individuals may acquire leasehold interest for a specific number of years in trust land and can (in theory) be repossessed by the local authorities should the need arise. Local authorities should retain regulatory powers over trust land.

Private land is land owned by private individuals under the Registered Land Act (Cap .300). On registration as the landowner, an individual acquires absolute ownership on a freehold basis. The use of private land may, however, be limited by provisions made in other legislation, such an Agriculture Act (Cap. 318). For instance, to protect soils the clearing of vegetation may be prohibited or the planting of trees required. Land preservation orders issued by the director of agriculture can cover a whole range of other measures. The Chief's Authority (Cap. 128) provides further powers for administration officials to undertake measures to conserve natural resources

Effectively enforced the act will direct the private owners of the vast tracks of land in Taveta area to undertake activities such as soil and vegetation conservation that will rehabilitate the catchment area in Lake Jipe ecosystem.

4.10 The Local Government Act CAP 265

This law empowers a Local Authority to apply through the Minister for Lands to meet its different development purposes. Such requests and purposes are deemed to be public purposes within the meaning of the Land Acquisition Act (Cap 295). Such a local authority may, within such land, establish and maintain a conservation area. It may also take measures necessary for the prevention or control of bush fires or quarrying for minerals, sand gravel, clay, or stones.

This Act empowers the local authority to apply through the Ministry of Lands to meet the requirements of projects in the Taveta area this notwithstanding that meet the different development purposes of the land in the area.

4.11 Relevant Policies

4.11.1 Draft Wetlands Policy

A substantial step forward in cross-sectoral wetlands management was the setting up of a National Wetlands Standing Committee (a sub–committee of the Inter-Ministerial Committee on Environment) in 1994. With co-ordination from the de facto National Environment Secretariat Wetlands Programme (now National Environment Management Authority), this committee is preparing a draft wetlands policy.

There is lack of coherent policy for wetlands management in Kenya, but steps are being taken to formulate one. In the absence of any clear controlling and coordinating authority, wetlands face

threats from a number of different directions. These include poor agricultural practices and deforestation in catchment areas, leading to soil erosion and the silting of rivers and lakes. Direct drainage for cultivation has destroyed many small wetlands and severely damaged others.

Water is generally scarce in Kenya and there are many competing demands. Increasing use for irrigation and industry, often not well regulated, has changed the water balance of many wetlands. Pollution and eutrophication are also intensifying at many sites.

Kenya is a signatory to the Convention on Wetlands (Ramsar, 1971). This convention gives contracting parties general responsibilities for wetland conservation and specific responsibilities for the wise use of listed sites. Four Kenyan sites are listed (Lake Nakuru, Naivasha, Bogoria, and Baringo). There is a need of including Lake Jipe, as it is a threatened and important transboundary lake that is critical to the stability of the Taveta ecosystems.

Legalisation to tackle environmental management problem exists; the difficulty lies more in institutional weaknesses and lack of co-ordination.

A substantial step forward in cross-sectoral wetlands management is the teaming up of NEMA and Kenya Wetlands Forum to try and complete the policy.

4.12 International Conventions and Agreements

Kenya is party to various international conventions and agreements on the conservation of bio-diversity. However due to political interference and financial constraints it hasn't effectively undertaken steps to adhere to the conventions and agreements pertaining to the conservation of bio- diversity. The relevant frameworks, that Kenya is a party to in relation to the Lake Jipe ecosystem are listed below.

Kenya is a party to the African convention on the Conservation of Nature and Natural Resources (signed in Algiers on 16 September 1968). It has also acceded to three important international convections that pertain to protected areas. These are the Convention on Wetlands; Ramsar Convention on Wetlands (signed in Ramsar, Iran, on 2 February 1971), the Convention on the Protection of the World Cultural and Natural Heritage (signed in Paris on 23 November, 1972) and the Convention on Biological Diversity (signed in Rio de Janeiro on 5 June 1992). Kenya has also acceded to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), signed in Washington (3 March 1973), the Convention for Protection, Management and Development of the East African Region (The Nairobi Convention adopted on 21st June 1985), but not to the Convention on the Conservation of Migratory Species of Wild Animals (signed in Bonn on 23 June 1979). Neither has Kenya acceded to the Convention for the Protection, Management and Development of the East African region (the Nairobi Convention, adopted on 21 June 1985)

4.12.1 Convention on Biological Diversity (CBD)

Convention on Biological diversity provides a framework for inland waters and transboundary ecosystems.

Article 14 paragraphs 1 (a) and (b) of the CBD concern environmental impact assessment of a party's proposed projects, programmes and policies.

Paragraph 1 (a) applies to all parties to the convention in which Kenya and Tanzania are signatory. Only those parties currently without procedures requiring EIA for their proposed projects which are likely to cause significant adverse effects on biological diversity can be required to introduce them.

Those parties with established procedures requiring EIA should, however, review them to ensure that effects on biodiversity are taken into consideration

4.12.2 Convention on Transboundary Environmental Impact Assessment

The Convention on Environmental Assessment in Tran boundary context (Espoo, 1999) addresses the procedural obligations of notification, exchange of information and consultation concerning activities with potential transboundary effects.

The obligation exists to the extent that impacts on biodiversity in other states or beyond the limits of national jurisdiction may occur.

Eastern Africa countries are also developing EIA guidelines for transboundary projects, programs and other policies/ventures that affect more than one country.

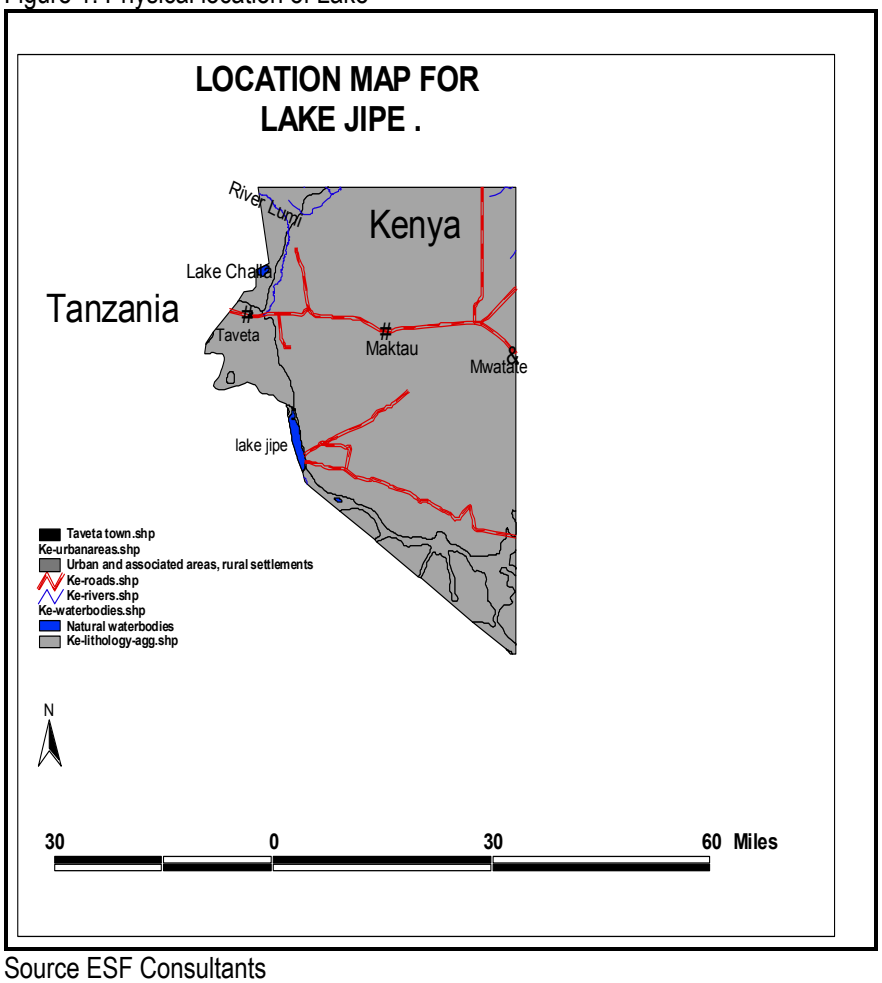
5 PROJECT AREA DESCRIPTION

5.1 Physical Environment

5.1.1 Location and Size

The Lake Jipe ecosystem is located southeast of Mt. Kilimanjaro as an international water body that straddles along the Kenya-Tanzania border. It is located in the southern part of Taita-Taveta district, about 20 Kms to the South of Taveta town, Taveta division along the Kenyan-Tanzanian border. The Lake (See figure 1 below) is in Jipe location with its larger portion lying within the Coast Province of Kenya while the smaller portion is found in the lee of Tanzania's north Pare Mountains in parts of Mwanga and Rombo districts. The Lake lies at about 700m above sea level (a.s.l.), and is neighboured to the west by Lake Challa. Lake Jipe is a small shallow lake with a maximum length of about 12 km, an area of about 28 Km^2 and an average depth of less than 3m and width varying between 2 and 3 km. Poor wetland and land management had greatly destabilised the wetland causing alarm among conservationist regarding its potential extinction.

Figure 1. Physical location of Lake



Source ESF Consultants

The lake is bordered to the south by Mt. Kilimanjaro, to the west by the North Pare Mountains, and to the Southeast by the Tsavo West National Park. The Southeastern quarter of the lake is within Tsavo West National Park; the Northeastern quarter is under Taita-Taveta County Council while the western half falls within Mwanga and Same districts in the Kilimanjaro region of Tanzania.

The wetland catchment within Kenya is approximately 680mm^2 (excluding National parks) of this, 48.5Km^2 is covered by swamps, 435Km^2 by sisal estates and 196.5km^2 by public land part of which is currently being allocated under the Jipe settlement scheme.

In Kenya the catchment stretches from the Eastern slopes of Mt. Kilimanjaro, from the upper reaches of the Lumi River to the edge of Lake Jipe. It extends to about 10 Km to the North of Lake Chala at the water divide of Lumi and Tsavo Rivers. It also includes an area up to 10 Km to the East of the Lake Jipe, which drains to the Lake, part of which is also within the Tsavo West National Park.

The catchment includes the various irrigation canal systems, which either feed the Lake or Ruvu River on the Kenyan side. The wetlands refer to the vegetated edges of Lake Jipe in Kenya and swamps edges of Ruvu River. The permanent and seasonal swamps, the open waters of Lake Jipe and of the wetlands and streams of Ruvu River in Kenya are part of it.

5.1.2 Climate-Rainfall/Temperature

The lake Jipe catchment area lies within ecological zone four (4) characterized by sub-tropical to semi-arid climatic conditions. Rainfall is not reliable and is medium to potential with annual rainfall ranging between 500-600mm. The area experiences biannual rainfall with the long rains occurring between March and May and the short rains between October and December. Maximum temperatures reach an average of 29.5^{o}C with the average minimum being 19.9 degrees centigrade. The hottest months are from January to April, and temperatures begin to fall from May to August with the coldest months being September. Mean annual evaporation is about 1930mm.

5.1.3 Geology

The Southeastern slopes of the Kilimanjaro volcanic belt are made up of several volcanic types of rocks associated with long and complex volcanic history. The Lake Jipe ecosystem is located on pleistocene calcareous tuffaceous grits with some minor volcanic vents of vesicular olivine basalts in its Northwestern part.

The southeastern flanks and Challa crater comprise of basalt, tuff and various ash deposits, which accumulated around numerous eruption centres. To the south towards Lake Jipe, the area is covered by calcareous tuffaceous grits some tens of metres thick overlying the basalt and ash sequence. Other areas are predominated by a thick red soil sequence developed over the basement system rocks. The entire volcanic sequence and metamorphic terrain has a general dip and manifested slope towards the south east; hence sheet and gulley erosion is more pronounced on the upper reaches of the Jipe catchment area.

5.1.4 Topography

The steep Southeastern slopes that run all the way from Mt. Kilimanjaro to be interrupted by the Challa volcanic crater characterize the Lake Jipe area. From the Challa crater where Lake Challa is located the slopes change into a gentle and relatively flat surface with the lowest point being located at Jipe.

Generally, the vast area covered by Lake Jipe basin consists of an extensive, flat to gently undulating piedmont plain, whose flatness is only broken by some volcanic vents, which rise several tens of metres above the plain. The overall slope is 1.5% in a southern direction.

5.1.5 Soils

Generally the Jipe catchment area may be divided into two main soil units

- Alluvial soils mostly characteristic of the marshy and swampy areas, and
- Dark red-to-red soils rich in iron (sandy, clay to loam) found in drier areas.

The soils vary, depending on deposition material. Well-drained sandy soils are found as well as poorly drained soils. The fertility of these soils is moderate to high. They receive fresh sediments and nutrients during regular floods and occur in all larger river basins, of the Bura, Lumi, Mbololo, Mwatate and Voi Rivers. Most fluvisols have a neutral pH, the exchange complex is saturated, but high sodium saturation is common and high salt levels can become a problem. Where the peneplain changes to a hilly landscape with inselbergs and residual hills, Acrisolls can be found. They are younger and less deep weathered and often shallow, compared with Ferralsolls.

Deeply weathered soils are widespread in the area. Highly fertile vertisols (black cotton soils) are characteristic for semi arid areas with a distinct rainy season in plains and depressions. The drainage and the handling of the soils are problematic because vertisols contain mostly clay, which hardens and cracks during the dry season and waterlog during rains. Their physical conditions are dependant on the level of soluble salts and absorbed sodium. The cation exchange capacity is high as well as the base saturation. Salinity in vertisols may originate whether from parent material or from irrigation (Driessen & Dudal 1991).

Around Lake Jipe permanent wet conditions occur. The reason is the shallow groundwater table (less than 1m), which enables the salts to deposit in the topsoil as the capillary water evaporates. This results in salinity and sodicity problems (Mugwanja 1997).

In the western part of the catchment, the soils have developed from the basement rock system with some influence of volcanic ashes. As the volcanic rocks are still young, there is hardly any soil development on them. The soil development is well drained, loamy and gravel. The chemical fertility of these soils is very high (Van Wijngaarden 1985).

Reddish, very deep, acid sandy-clayey soils (ferrasols) exist in the semi-arid plains of the lowlands. They are commonly found in the whole of Tsavo National Park and the ranches. These soils are vulnerable to soil erosion and characteristised by low water holding capacity and soil fertility. Due to the stability of the land surfaces over a long period, ferralsols are strongly weathered. As weathered minerals are absent, the amount of plant nutrients is low. A problem is the strong

inactivation of phosphorus as well as deficiencies in nitrogen and potassium. Ferralsols have a limited water holding capacity, making them sensitive to droughts (Were 1986).

5.1.6 Results of the Soil Sample Analysis

In the study, 5 soil samples were taken in different areas. The results from the soil sample analysis are described as follows.

Soils acidity (PH) values: the nutrient availability is directly related to the PH value of soils. With lower PH values some nutrients, i.e. the important phosphate and potassium ions, become less available for plants, some micronutrients and heavy metals become more available, whereby aluminum toxicity can become a threat. High pH values cause a reduction in nitrification and availability of micronutrients.

The highest values are found in samples from the irrigated areas in the area ranging between 7.0 and 9.0. Higher pH values in can be attributed to the volcanic parent material but are mainly caused by irrigation activities. Another reason for high pH readings are the clayey soils which have a high cation- exchange capacity and base saturation

Total nitrogen (Nt) content: nitrogen is the most important nutrient for plant growth and most plants react sensitively to nitrogen deficiency. Nitrogen measurements are difficult to interpret since the types of nitrogen present and their relevance to crop nutrition are unknown (Landon 1991,138).

Most of the samples range between adequate and low. In general, the nitrogen supply can be seen as insufficient in many areas. In most soil samples the amount of nitrogen decreases with soil depth to the fast ammonification process, which is a typical effect in tropical soils as the amount of organic matter is higher in the topsoil. Another reason for higher nitrogen content in the topsoil can be seen in the activity of nitrogen fixing root bacteria (e.g. of legumes), which increases the available nitrogen in soils.

Organic carbon (C_{org}) content: organic matter, generated from the decomposition of dead biomass, increases the stability of soil structure, water availability and air capacity. The organic matter content of top soil; in semi arid climate is generally low due to scarce rainfall and high temperatures. Therefore the organic carbon, a product of the biological mineralization process of organic matter is low in soils of dry areas.

Due to the climatic conditions, sufficient contents of organic carbon can only be found in highlands, in the semi arid areas of the district samples hardly exceed 2% (C_{org}), which can be classified as low to moderate. Even though the area belongs to the ASAL, the rating of organic carbon is mainly moderate, probably due to irrigation.

Available potassium (K) content: in addition to nitrogen and phosphorus, potassium is an important nutrient for plant growth. Plants absorb exchangeable as well as non- exchangeable potassium and both forms of plant available potassium were measured in the analysis. The content in soils depends on the parent material.

According to the samples taken available potassium content can be considered to be low in the area. In most samples, the potassium content is higher in the topsoil compared with the subsoil, but in general the content of plant available potassium is not sufficient.

Available calcium (Ca) content: depending on climatic conditions and parent material the content of calcium as an essential plant nutrient can vary considerably. Normally, calcium deficiency occurs only in soils of low cation- exchange capacity (CEC) at pH values of 5.5 or less. Calcium promotes flocculation of clay micelles and can therefore stabilize the soil structure of sodic soils. High calcium contents are characteristics in the soil samples from the irrigation schemes in Taveta. In these areas, hard calcareous layers of volcanic origin and a volcanic horizon or a concentration of soft powdery lime, typical for vertisols in dry areas, occur. This could be the explanation for high carbonate contents and the transportation of carbonates to the topsoil with ascending capillary water.

Available magnesium (Mg) content: the other important form of carbonates is magnesium carbonate. The content of magnesium is dependent on the parent material and is mainly found in sedimentary rocks. It is an essential constituent of chlorophyll vital for photosynthesis (Tan 1996).

The supply of available magnesium is high in Taveta. Similar to Calcium, the Magnesium supply is related to the carbonate content of the parent material.

Electrical Conductivity (EC) the preferred index to assess soil salinity is electrical conductivity. It measures the total quantities of soluble salts. High temperature and evaporation rates are an additional factor in increasing the concentration of salts. Inadequate drainage and poor irrigation management can cause salinity, likewise a high ground water table or low soil permeability. Low permeability can be the result of sodicity and high ground water table in conjunction with high evaporation rates and little rainfall. This leads to the crystallization of minerals in the topsoil as the capillary water evaporates. This affects crop growth and yields, as the osmotic pressure cannot be regulated. Hence the nutrient and water available to leach soluble salts from the soil. As a consequence, salts accumulate leading to salt affected soils. In higher rainfall areas salt accumulation normally does not occur because, due to sufficient rainfall, excess salts will be leached out of the soil (Landon 1991, Sparks 1995)

Crop losses can be severe where the EC exceeds 1.8Ms/cm (KARI/NARL 2000). The extent of salinity in the district does not reach such high values but saline appear in irrigated areas. In most of the irrigation schemes in Taveta the EC is higher in the topsoil (0-20cm depth) than in the sub soil. Chala, Kivalwa/Maweni and Kimorigo are the most affected areas.

The results of the analyzed samples show that in most of the sample sites the amount of nitrogen and available potassium is low. The deficiency of these important plant nutrients may cause yield reduction in some areas.

The area is a high potential area for agricultural production due to moderate to high fertility of the soils and availability of water. Soils are especially rich in calcium and magnesium. However in these irrigation areas limiting factors might be saline elements accumulating in the upper layers of heavy clay soils due to low infiltration, high evaporation combined with capillary ascending minerals and a high pH.

Precise interpretation of EC data is difficult because the salinity is modified by factors such as: climate and season, quality of irrigation water, soil texture and durability, salt types present and crops (Landon 1991). Taking into account that the samples were taken during the long rains (March) and the analytical method used was not adequate for the clayey soils, even higher amounts of saline elements can be expected. In addition saline accumulation on the soil surface have been investigated in the course of transects, sampling and ground checks. Salinity problems in the irrigation areas/schemes have been reported from different people and literature. Several schemes have been partly abandoned because of accelerating salinity and sodicity.

Following this interpretation, a difference in the degree of salinization between northern and southern of the catchment could not be seen although the ground water table varies; rather the extent of salinity is influenced by soil texture.

Due to poor management and the state of many irrigation schemes, salinity has become a major problem. An adequate drainage system could vastly improve the present situation.

Fertility in the surveyed lowland localities is adequate to low. Organic carbon and organic matter appear in small quantities due to prevailing climatic conditions. In addition to the nutrients mentioned above, other important nutrients such as Calcium and Magnesium appear in smaller quantities due to sandy soils and lack of organic matter. However, the major factor limiting crop production is the soil water availability. Low water holding capacity of the soils, in combination with prevailing climatic conditions, limits crop production.

Table 1. Soil Sample Analysis

ELEMENT	UNIT	SAMPLE 1	SAMPLE 2	SAMPLE 3	SAMPLE 4	SAMPLE 5
pH		7.7	8.2	8.1	7.9	7.5
Total Nitrogen (N_t)	%	0.12	0.27	0.22	0.41	0.30
Phosphorus (P)	ppm	69	109	131	77	123
Potassium (K)	(me/100g)	0.92	0.87	0.88	0.45	0.61
Calcium (Ca)	(me/100g)	17.0	16.4	16.6	13.4	18.1
Magnesium (mg)	(me/100g)	5.2	3.6	4.7	3.9	4.1
Sodium (Na)	(me/100g)	1.21	1.30	1.78	1.46	1.32
Electrical Conductivity	mS/cm	1.3	1.5	1.5	1.4	1.6
Iron (Fe)	ppm	145	234	252	179	314
Manganese (Mn)	(me/100g)	0.14	0.23	0.25	0.18	0.11
Copper (Cu)	ppm	1.3	2.1	1.8	1.2	1.1
Zinc (Zn)	ppm	6.63	7.11	5.34	5.31	6.01

To determine the existing characteristics of soils along the watercourse, samples were taken for analysis. A total of 5 samples were taken from the following areas as follows.

Sample 1 - Along River Lumi near El doro
Sample 2 - Along River Lumi at Kimorigo area

Sample 3 - Along River Lumi at Kimorigo area
Sample 4 - Along River Lumi at Kimala irrigation scheme
Sample 5 - Along the shores of Lake Jipe in Kachero village

5.2 Hydrological Regime

5.2.1 Surface Drainage

Broadly speaking, the Taveta area as a whole is drained by three rivers, the Ruvu, the Lumi and the Tsavo. However, the main source of all the water is the Lumi River and the many springs that feed it. There are three groups of springs in the Lake Jipe area, the most important being the Lumi Springs, comprising the Lenonya on the eastern banks of the river, the Kubwa Njoro and Maji ya Waleni on the western bank. These springs increase the flow of the river from 5 to 300 m^3/sec in about 6 kilometers. The largest of the springs is the Njoro Kubwa whose aggregate discharge is about 290 m^3/sec. (Taita Taveta Water Master Plan 1995).

The second group of springs forms the headwaters of the Njukini, Sembeki and Njoro streams. There is a strong possibility of other springs discharging underground into the northeast corner of the Lake Jipe.

The Lumi River comprises the most significant drainage system in the Lake Jipe watershed. The headwaters of the river start form the Southeastern slopes of Mt. Kilimanajaro. Surface runoff from Mt. Kilimanjaro form small tributaries to the Lumi River. These tributaries remain dry most of the year and the perennial flow of the Lumi River is maintained by a system of high yielding springs. A series of these springs join Lumi River until it empties in Lake Jipe. Before emptying into Lake Jipe, the Lumi River enters into an alluvial flood plain which gradually merges into a large swamp estimated at over 45 kms squared, (Kaldes, 1986), the latter one being connected with the Ruvu river and swamps to the west.

The River Lumi provides continues supply of water with seasonal fluctuations. In dry season the river discharge is approximately 0.3 m^3/s. In the wet season Lumi River contains a large percentage of floodwaters and often overflows its banks. A record of 4-5m^3/s discharges into Lake Jipe during wet season has been reported (Lake Challa Water Resources Development Project, 1994).

The Lumi drainage basin is approximately 451 km^2, a quarter of which lies on the lower slopes of Kilimanjaro, where rainfall is heavy and runoff high. The river is subject to occasional floods, which are often of considerable magnitude and can be a serious menace to the railway and road bridges and also the irrigation projects in the lower areas of the river. The hydrology of the area indicates that some of the rivers that previously discharged into the Tsavo River deflected into the R. Lumi as a result of vulcanicity during the Tertiary period. Table 2 below shows the mean annual water level, discharge and suspended load for River Lumi in the 1950s, 1960s and 1980s. The results show that river discharge has declined significantly in recent years. Lake Jipe outflows into the Ruvu River, which is a tributary of the Pangani River. It has a mean flow of about 130 m^3/sec near the outflow of Lake Jipe.

The Lake and its swamps have been regarded as a storage basin for the Ruvu although the discharge increases tremendously immediately below the Lake giving a strong indication of high subsurface input.

Table 2. Mean annual water level, discharge and suspended load for River Lumi from 1950-1980

Year	Water level (cm)	Discharge (m^3/s)	Suspended load (ppm)
1954	106	70	2442
1955	210	143	5473
1958	74	33	276
1959	54	12	30
1960	135	65	385
1961	158	-	1214
1980	-	1	23

Source: GoK-JICA (1992)

The river gauging stations of the Lumi river system are shown in table 3 below. The table presents lowest flow measurements for Lumi river basin system.

Table 3. Lowest flow measurements for Lumi river basin system

5.2.1.1 Source	Lowest Discharge m^3/d
Kitobo Springs	46,051
Madulu Springs	12,614
Njoro Kubwa Springs	345,600
Njoro Springs	10,368
Sembeki Springs	4,320
TOTAL	418,953

Source. Water Master Plan. Taita Taveta District Phase 2, June 1995.

5.2.1.2 Ruvu River

Ruvu River is the major surface outflow of Lake Jipe. It leaves the Lake at its northeast corner and flows westward to form the Pangani River in Tanzania. Kitobo also feeds the Ruvu River springs together with the eventual tail waters of the Njoro Kubwa canal. Along the eastern stretch of the Ruvu River follows an indefinite course through swamps estimated to cover about 30 $km^{2.}$ The average flow of the Ruvu River at its outflow from Lake Jipe is about $5.5m^3/s$ (Water Master Plan. Taita Taveta District 1995)

5.2.1.3 Springs

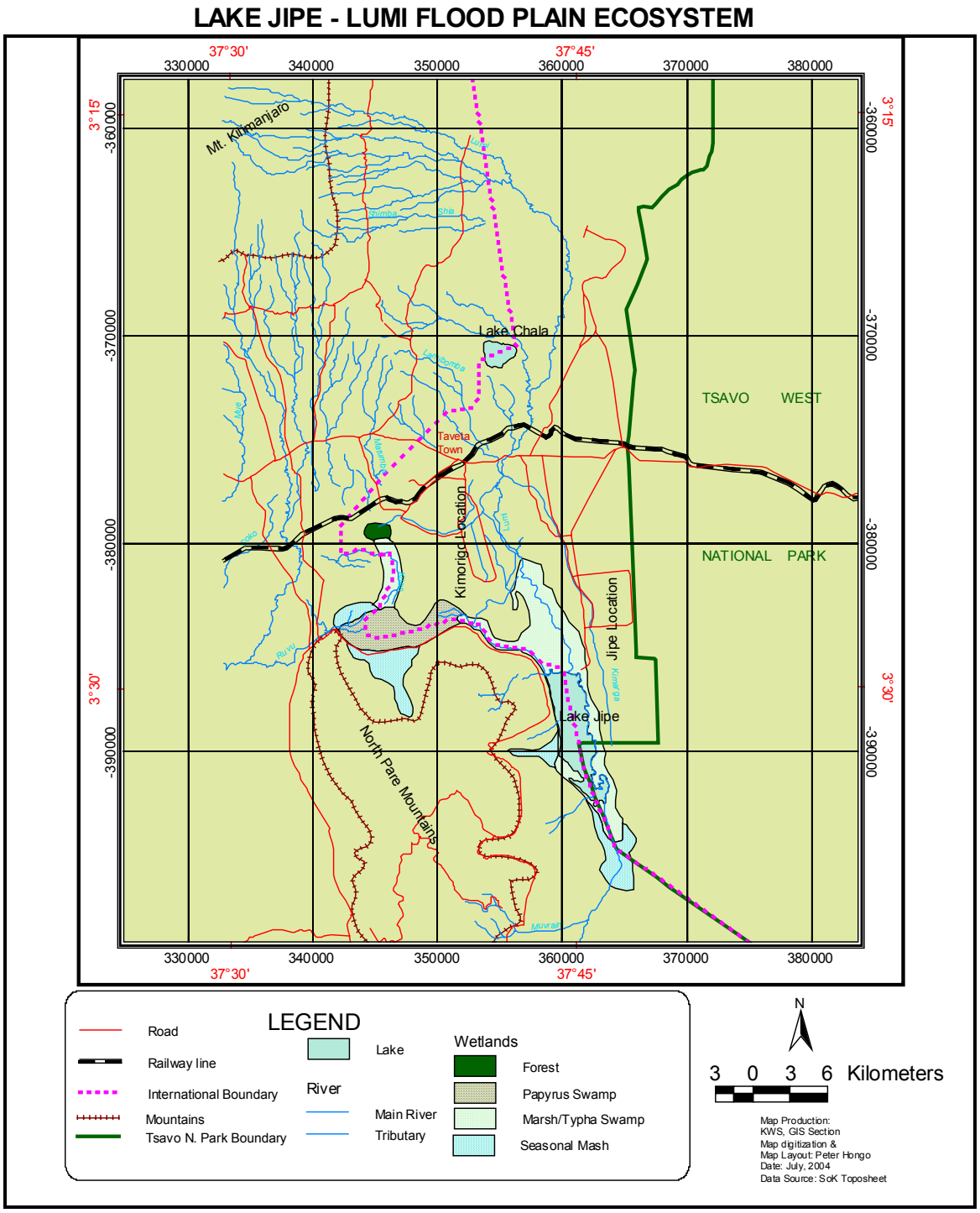
The wetland is also served by various spring systems which are associated with Lumi and Tsavo Rivers. The major spring is njoro Kubwa spring which feeds into river Lumi.

5.2.2Lake Water Budget

Mount Kilimanjaro surface runoff from the eastern slopes of the mountain is the main water catchment of the Lake which feeds into the Lumi River and flows to Lake Jipe in seasons when there is sufficient local rainfall to maintain this river as shown on the GIS referenced Lake Jipe-Lumi flood plain map in the next page. The slopes of Mt Kilimanjaro are all in Tanzania while the

Lumi River runs through Kenyan territory, past the Taveta town and to the Lake. Subsurface waters also feed River Lumi from Mt Kilimanjaro.

Figure 2. Lake Jipe-Lumi flood plain map



The Lake catchment basin is approximately 451 km^2, part of which lies on the lower slopes of Kilimanjaro, where rainfall is heavy and runoff high. The river is subject to occasional floods. The hydrology of the area indicates that some of the rivers that previously discharged into the Tsavo River deflected into the Lumi as a result of volcanicity during the Tertiary period. Lake Jipe outflows into the Ruvu River, which is a tributary of the Pangani River. River Ruvu has a mean flow of about 130 m^3/sec near the outflow of Lake Jipe. The Lake and its swamps have been regarded as a storage basin for the Ruvu although the discharge increases tremendously immediately below the lake giving a strong indication of high subsurface input.

5.2.3 Groundwater Dynamics

Snow melting on Mt. Kilimanjaro in Tanzania at 5895 m fills into River Lumi that flows through Kenya to enter Lake Jipe through a large *Typha* swamp of approximately 20km^2 at the northern part of the Lake; and which blends into River Ruvu swamp in Tanzania as the outlet for the lake. The metamorphic Pare Mountains in Tanzania rising to about 2113m also have permanent streams like the Kirurumo River flowing into the lake through the southern swamps, and also contributing significant underground recharge into the lake. Subsurface waters appear to be making significant but unknown contribution to the present water levels in this lake, which is fairly constant through out the year despite the prevailing semi arid conditions. The waters of this Lake leave through a large swamp of about 35km^2 on both sides of Kenya and Tanzania to empty into Nyumba ya Mungu through the Ruvu River channel with the lake therefore acting as a reservoir for Pangani River. Lake Jipe is a water storage organ and its swamps act as sediment traps and water purifiers releasing water of 200υS/cm compared to 800υS/cm of the main lake. (Water Master Plan. Taita Taveta District Phase 1995)

5.2.3.1 Ground Water Resources

There are about 150 groundwater sources including boreholes and shallow wells. These are mainly used for domestic, small-scale irrigation and livestock watering.

5.2.3.2 Nature of Existing Wells

The boreholes in Taveta division have been drilled in the volcanic aquifer system, which is characterized by high ground water potential due to high permeability of the pyroclastic formations and storage at volcanic/basement interface. These boreholes have been drilled to depths ranging between 15- 68m below surface. Water is struck at levels between 13-61m, and water rest levels between 13 - 35m and yields between 240 -571m^3 per day (Water Master Plan, Taita Taveta District Phase 2, 1995).

Groundwater tables in some areas of Taveta are to be found at relatively very shallow depths between 0.5-2m below surface. This is also the range at which most shallow wells that forms the bulk of ground water resources exist. This is prevalent in central parts of Kimorigo and Kamleza, where the calcareous ruffaceous grits underlying the area. The formation is porous from surface to about 10- 20m below surface and shallow ground water is perched within this depth range. From about 20m below surface, the calcareous formation becomes impervious preventing percolation of water into deeper aquifers.

5.2.4 Water Quality of the Wetland (Eutrophication)

This section provides an in depth analysis of the state of water from the mentioned wetland in terms of its quality and discusses the eutrophication levels as well as providing results of water samples tested from various parts of the wetland and its tributaries. Table 4, 5 and 6 respectively below indicate the results of the water samples tested from Njoro Kubwa Springs, at the shores of Lake Jipe, and 2 kilometeres away from the shores of Lake Jipe.

Table 4. Results of the chemical analysis taken for Njoro Kubwa Springs

Source	Njoro Kubwa Springs
pH	8
Chloride	5
Turbidity	156
Electrical Conductivity	810 Micromhos/cm3
Alkalinity	346
Total Hardness	536
Chlorine	280
Calcium	109
Magnesium	536
Total dissolved substances	435
Salinity	462
Sulphate	<50

(Source: Ministry of Water, Report on chemical analysis of water samples collected at the Njoro Kubwa springs, April-June, 2004)

Table 5. Available chemical analysis data for Lake Jipe at the shore

Source	Shore of lake Jipe
pH	8.1
Chlorine	10
Turbidity	28.5ntu
Electrical Conductivity	360 Micromhos/cm3
Alkalinity	346 NGL
Total hardness	220
Chloride	41mg/l
Calcium	41mg/l
Magnesium	29
Total dissolved substances	180
Salinity	68
Sulphate	NIL

(Source: Ministry of Water, Report on chemical analysis of water samples collected at the shore of Lake Jipe, April-June, 2004)

Table 6. Available chemical analysis data for Lake Jipe, 2 km from the shore into the lake

Source	2Km into lake Jipe
pH	-
Chlorine	25
Turbidity	37.5
Electrical Conductivity	1,020 micromhos/cm3
Alkalinity	1,046
Total hardness	124
Chloride	246
Calcium	246
Magnesium	5
Total dissolved substances	510
Salinity	406
Sulphate	<50

(Source: Ministry of Water, Report on chemical analysis of water samples collected 2Km from the shores of Lake Jipe-into the lake, April-June, 2004)

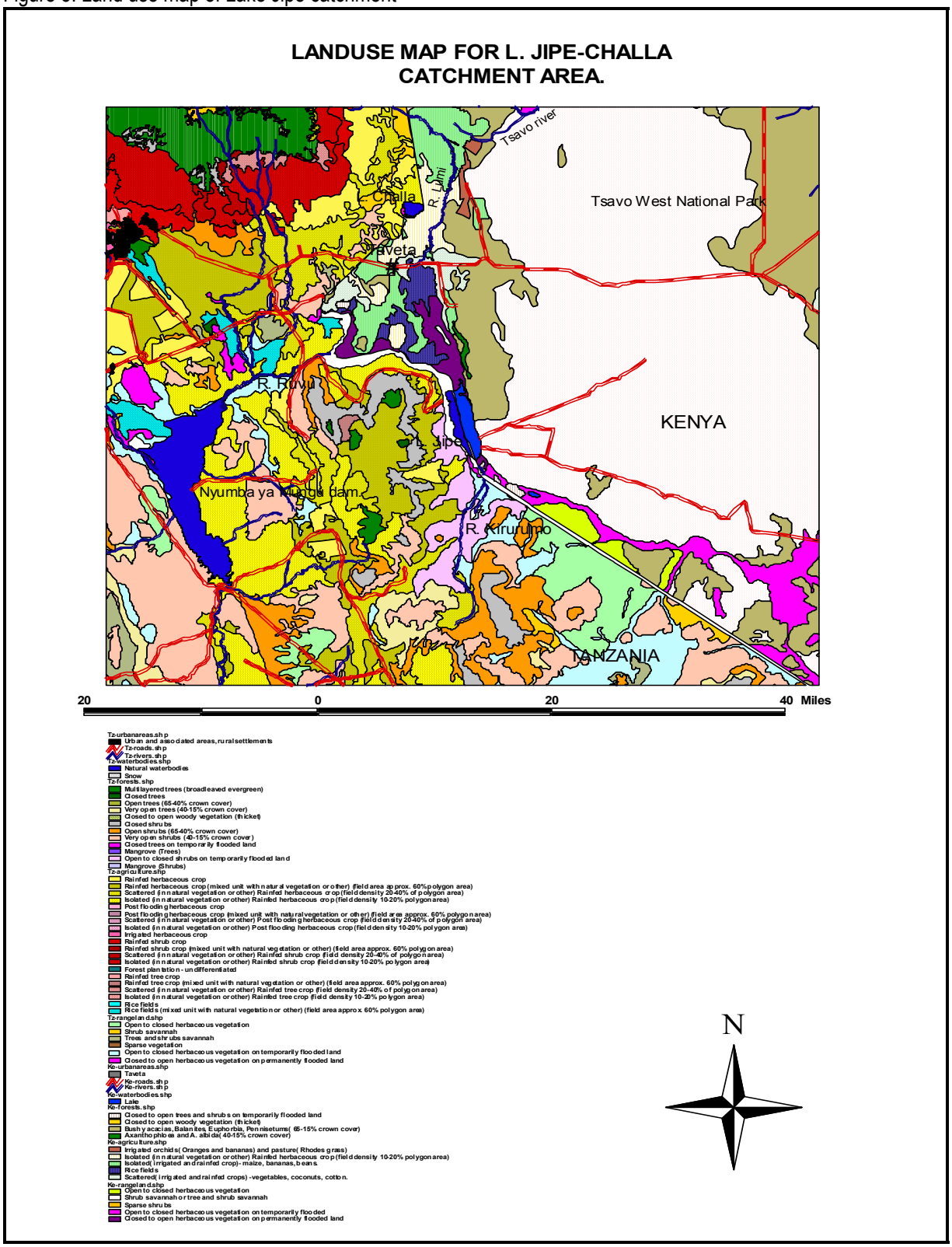
5.2.5 Flood Risk

The source of the River Lumi is on the slopes of Mt. Kilimanjaro. From Ziwani to the Njoro Kubwa springs, it flows in a deeply eroded channel whose average depth is about 3.5m. The average flow rate of the Lumi River below the junction of the Njoro springs is $7m^3$/sec; and it's catchment area is of the order of $590Km^2$, a quarter of which lies on the slopes of Mt. Kilimanjaro, where the rainfall is heavy and run-off percentage high (MoW. 1990). Therefore the River Lumi is subject to floods, often of considerable magnitude (peak flood discharge has been estimated to be $200m^2$/sec) and which are a menace to road and railway bridges, and to the irrigation projects and settlements.

Part of the water of the Njoro springs is led into the Njoro Kubwa canal feeding the irrigation system of the Taveta sisal estate and the downstream squatter irrigation schemes. Further downstream the Lumi River debouches onto an alluvial floodplain over which it flows as an elevated trough which gradually merges into the Lake Jipe swamp, which is connected with the Ruvu swamp to the west. This causes the water level of the lake Jipe to rise and flow into Tanzania, in the gap between the North West tip of the Pare Mountains and the lower, southern slopes of Mt. Kilimanjaro. However, the silting effect of Lake Jipe and the topographical conditions have led to the development of swamps, which impede the movement of water towards the gap. The level of the Lake is gradually rising due to the impeded drainage, and the deposition of sediments at the bottom of the lake.

Figure 3 below is a Land Use map illustrating the different land use activities occurring in the study area.

Figure 3. Land use map of Lake Jipe catchment



5.3 Biological Environment

5.3.1 Forest/Vegetation cover

The natural vegetation is mainly wooded bushed grassland with Acacia species and perennial grasses dominating. The distribution of individual plant species seems to follow closely the moisture conditions and the chemical nature of the soils.

The area which is adjacent to the river Lumi and which has well drained soils is dominated by a riverine forest, of which dominant tree species include *Acacia xanthophloea, Acacia albida*, and *Ficus sycomorus*. Other areas which are slightly further away from the river, and have imperfectly drained to poorly drained, and saline and sodic soils, have a wooded grassland vegetation type, dominated by the woody species *Acacia seyal, Acacia tortilis*, and *Salvadora persica*. The dominant grass species in this area include *Sporobolus consimilis, Sporobolus spicatus*, *Sporobolus ioclados*, and *Sueda monoica*, which may be indicative of strong saline and sodic soil conditions. Other grass species, which are found in places which are poorly drained with a high ground water table, are *Cynodon dactylon*, *Cyperus papyrus*, *Cyperus laevigatus*, *Cyperus latifolius*, and *Typha domingensis*.

The areas which are furthest away from the river Lumi and are bordering the Eldoro and Kitogoto hills are also covered with bushed grassland, dominated by the grasses *Cynodon dactylon*, *Digitaria scalarum, Cenchrus ciliaris,* Chloris *roxburghiana*; the tree *Acacia seyal* and the bush *Abutilon mauritianum*. These areas have generally well drained soils, which are also less saline or sodic.

The following is a detailed database of vegetation description for the Taveta area:

(FAMILY *LEGUMINOSAE*/ SUB-FAMILY *MIMOSOIDEAE*)

- ***Acacia albida.*** **(Apple ring acacia).**

Often found in riverine dry areas or where the water table is near the surface. Widely used in dry land agroforestry. This species has a deep tap root system, fast growing even in poor soils if ground water is adequate. The tree is nitrogen fixing; leaves are retained in the dry season and fall in the rains, and both leaves and pods are excellent fodder.

- ***Acacia seyal*** **(White thorn)**

Widely distributed in wide grassland especially in black-cotton, alluvial and/or stony soils. The tree produces an edible medium-quality gum, widely used in traditional medicine to treat colds, dysentery, and stomach ache.

- ***Acacia xanthophloea*** **(Fever tree, Naivasha thorn)**

Gregarious in high ground water areas besides L. Jipe and R. Lumi, often in black- cotton soil. Also found in low-lying swampy areas along the R.Lumi in Kimorigho irrigation scheme. The tree is fast growing and attractive as an ornamental.

- ***Acacia tortilis*** **(Umbrella thorn)**

A hardy acacia with hard red wood that makes excellent firewood and charcoal. Locally known as "Mgunga". The spreading root system makes it a good sand stabilizer, and the pods and leaves are much eaten by game and stock, particularly goats.

(Family *LEGUMINOSAE*, sub family *MORACEAE)*

- ***Ficus sycomorus*** **(Sycamore fig tree)**

It is indigenous within the area. Widely distributed near R.Lumi and the Njoro springs. The leaves dry exceptionally fast after falling. The figs are much eaten by birds, monkeys and baboons. They have a powerful rooting system, which conserves the sandy –clay-loam soils**.**

(Family *PALMAE*)

- ***Cocos nucifera*** **(Coconut palm)**

Is called "mnazi" locally and is an indigenous species. Widely distributed in Kimorigho area on light sandy soils and tolerates salts. Fruits are eaten as food and its sugary milk is a refreshing drink which can be fermented to an alcoholic brew. Leaf fronds are woven into an attractive roofing thatch known locally as "makuti".

(Family *PANDANACEAE)*

- ***Pandanus kirkii*** **(Screw pine/walking palm)**

It is indigenous and widely distributed along river Ruvu. Locally known as "Mkadi". It is found along R.Ruvu on the strand just above the high water mark. Stilt roots arising from the lower trunk anchor the tree in the sand; dried leaves have been used for weaving mats, baskets and in many areas were used for thatching.

(Family *LEGUMINOSAE*, sub family *PAPILIONOIDEAE*)

- ***Dalbergia melanoxylon*** **(African Blackwood/African Ebony)**

Is locally known as "Mpingo" and is indigenous .Is scattered in low altitude woodland. The heartwood is a beautiful purplish black, very hard and durable, making it a valuable timber for boat making and woodcarvings. The increasing scarcity of this species, which takes many decades to mature, is a matter of concern.

(Family *ANACARDIACEAE*)

- ***Anacardium occidentale*** **(Cashew nut)**

Cashew nut is locally known as "Mkanju". The cashew nut apple is edible and slightly acid; the juice can be drunk fresh or fermented into liquor wine and the pulp can be used for making jam. The cashew shell oil can also be mixed with cement for weatherproofing and used as wood preservative against termites and the distilled oil is used in the manufacture of varnishes, inks, tiles and even brake linings. It is found in kimorigho area on well-drained sandy soil.

- ***Mangifera indicia*** **(Mango)**

Is locally known as "Mwembe" and widely distributed in irrigation schemes and along River Lumi and Njoro springs.

(Family *BALANITACEAE*)

- ***Balanites aegyptiaca* (Desert date)**

It is indigenous and locally known as "Mjunju". It is widely distributed towards L. Challa, Ziwani estate, Maho village, Timbila village and Kimala area which are intensive grazing areas for both game and stock. Often found on sandy or black cotton soils.

The fruit is greatly valued both for its fruit and its uses for stock, especially goats. The wood heavy, durable and termite resistant, and is used for carving and making farm tools as well as for fuel. The bark is used as fish poison and the fruit, although harmless to human and warm-blooded mammals, produces a potent emulsion which kills both the fresh- water snails that carry bilharzias and water fleas that carry guinea worm disease.

(Family *BOMBACEAE*)

- ***Adansonia digitata* (baobab)**

It is indigenous and locally known as "Mbuyu". Widely distributed around the lake Jipe area and most common in the grazing areas towards Kimala, Ziwani, Maho, Mata and Timbila areas. The leaves are used as a vegetable and the fibrous bark is used for weaving and making rope. The tree shows remarkable powers of regeneration after being distributed.

(Family *LEGUMINOSAE* subfamily *CAESALPINIOIDEAE*)

- ***Tamarindus indicia* (Tamarind)**

It is a dense, shady evergreen tree locally known as "Mkwaju" or "Msisi". The fruit pulp is edible and popular for flavouring curries and maize meal and long recognised as a laxative and a treatment for fevers. The dark brown heartwood is tough and well grained, useful for boat building and furniture and also making very good charcoal.

***Afzelia quanzensis* (Pod mahogany/ Lucky bean tree)**

A large indigenous deciduous timber tree. It is quickly disappearing. The timber is hard and durable in salt water. The tree is now sadly rare and deserves extensive replanting.

(Family *CAPPARACEAE*)

- ***Boscia coriacea* (Buscia)**

Is indigenous and locally known as "Mnafisi". Widely distributed towards the lake Jipe ecosystem borders with Tsavo West National Park. The fruits are popular with fruit eating birds and Baboons.

(Family *COMBRETACEAE)*

- ***Terminalia catappa* (Indian/Bastard-almond)**

Is locally known as "Mkungu". It is a handsome tree, fairly fast growing from seed, preferring sandy soil and tolerating salt. The tree develops an extensive roofing system.

- ***Terminalia prunioides* (purple-pod terminalia)**

Indigenous in Taveta and locally known as "Mwanga". It is widely distributed in dry acacia bush land. The fruit persists on the tree and the leaves are browsed by game.

(Family *EUPHORBIACEAE*)

- ***Euphorbia candelabrum* (candelabra Euphorbia)**

Is indigenous and widely distributed on sandy and rocky sorts towards L. challa, Ziwani Estate, Mata, Maho areas, and Kimala. It is also found around kimorigo area. Abundant nectar attracts bees, but the honey is rarely eaten as it irritates and burns the mouth.

(Family LAURACEAE)

- ***Persea americana* (Avocado)**

Produces fruits rich in fat, protein and vitamins. Grown in orchids on Kimorigho irrigation schemes.

(Family RUTACEAE)

- ***Salvadora persica* (Toothbrush tree)**

It is found in places with saline to sodic soils and is locally known as "Mswaki". Infusions from its roots and leaves are widely used in traditional medicine, and twigs are used for cleaning teeth.

5.4 MAJOR INVADER SPECIES

- ***Salsola dendroides*** (Salt bush)

Common towards the swampy areas with saline and Sodic soils. The grass associated with it is *Sporobolus spicatus.*

- ***Prosopis juliflora*:** Locally known as 'Mrashia'

Widely and fast spreading around Njoro springs (Reureu Village), Maho village and towards Timbila and Mata villages. Low lying bushy species to a tree with thorny stems. It is common on light sandy-loam soils and does not prefer heavy clay/cotton soils. It colonizes bare soils faster and suppresses the growth of other vegetation species. It is deep rooted and grows to form bushes and sometimes it can be a tree. Undigested pods eaten by goats are said to germinate in their tracts. Goats relish pods. Thorn pricks are however toxic to both human and stocks, and termites easily attack poles.

- ***Typha domingensis*:** Is locally known as "Gugu maji" and is predominant in silted areas of Lake Jipe and River Lumi. Apart from thatching, the weed is of no other major socio-economic use. The growth of the typha weed is much favoured by heavy siltation. Therefore it invades the lake and the river at areas where siltation is rampant and it follows the spread of silt. During heavy rains when the water levels increase and the silt levels go down, Typha floats and dies due to lack of stability and nutrients offered by the silt.

Figure 4. Invasive species in the lake

5.5 SWAMPY VEGETATION

The vegetation of the Wetlands is dominated by bulrush or reed mace, and *cyperus.* Major swampy vegetation species observed are:

- *Cyperus latifolius*
- *Cyperus papyrus*
- *Cyperus laevigatus*
- *Typha domingensis*

5.6 MAJOR GRASSES

- ***Cynodon dactylon* (Star grass)**

It is found in areas where organic matter is high. The grass is highly palatable and can withstand a lot of grazing pressure.

- ***Sporobolus spicatus***

It is a grass found growing in alkaline soils. It produces very low leaf biomass and is of low grazing value.

- ***Pennisetum clandestinum* (Kikuyu grass)**

A low lying grass that spreads fast on the ground. It is very important as it provides good ground cover thus holds soil in situ and conserves soil moisture.

- ***Pennisetum mezianum***

The grass has a low leaf biomass and the leaves are palatable when young. It is good for zebras during the dry season, as the growth remains green into the dry season. It is important in holding soil in situ.

- ***Pennisetum perpureum* (Elephant/nappier grass)**

Young stems are palatable when young and is a good grass especially for the dairy industry. The grass is also grown along River Lumi banks as bank reinforcement.

Planktons Existing in the Lake Jipe Catchment

There are around 50 species of submerged, emergent and floating plants in the lake and wetlands and an abundance of climbers that use the bulrushes and papyrus for support.

5.6.1 Existing Wildlife/Fauna

The study area is home to a diverse population of fauna that inhabit the Lake Jipe and its ecosystem. Wildlife is known to migrate from the expansive Tsavo National Park to the wetland in pursuit of pasture and water. Herbivores, carnivores, Ungulates, reptiles are among the different wildlife species that have adapted to the environment around the Lake Jipe catchment area. Below is a description of the different animal wild species that are found in this area.

- The African Elephant (*Loxodonta africana*)

Quite a number of African elephants have been witnessed visiting the Lake Jipe to drink water. They like to feed on the *Typha dominengensis* that's thriving well at the banks of the Lake. They have been reported cases of elephants feeding on the crops of the villagers adjacent to the Lake. The constant destruction of crops by elephants has discouraged most of the farmers from faming. Their need for drinking water encourages them to visit the lake and in the process destroy the crops on farms along their way. The African Elephants are threatened by poaching or attack from irate members of the public whose crops have been destroyed.

Figure 5. Elephants from Tsavo National Park visiting Lake Jipe to water and graze

- **The Black Rhinoceros** (*Diceros bicornis*)

They are quite a number but aren't often sited. They prefer open grassland savannah with scattered bushes, which offer a suitable location to camouflage against predators or poachers. They depend on the water source but unlike the Elephants they prefer to visit the area of the Lake that is not inhabited by humans and they are threatened by poaching.

- **Hippopotamus**

The population of Hippos is considerable. They are a menace especially to the people living very close to the river Lumi and the lake banks. They constantly invade the farms near the rivers destroying drops. They also damage dykes and riverbanks in the process. This causes flooding of farms located very close to River Lumi. They face the threat of being killed by angry residents whose farms have been destroyed. Hippos are a menace especially in the Kimorigo area. Suggestions of separating river lumi from farms by digging ditches have been ignored especially by farmers whose farms are an inch away from the river, as they fear loosing sections of their farm.

- **Grevy zebra,**

These are not oftenly spotted as they shy way from human settlement. They can only be seen on the section of the lake that falls under the Tsavo National Park.

- **Lion (***Panthera leo*),

They are not spotted at all times. On occasions they attack the livestock of the villages near the Lake i.e. Kachero. The conflict was rife when the lake was dry but now that it has water, the Lions are rarely sited unless they are visiting the lake at night. When the lake was dry they could be spotted even during the day roaming around in search of food and water.

- **Colobus monkey (*Colobus guereza***

There are quite a number in the area especially along rivers Lumi and Ruvu. The monkeys are a menace in that they feed on crops ready for harvest in farms. This result into a huge loss to the farmers in terms of potential income to be accrued from the sale of the produce and a reduction of

quantity of food harvested. The monkeys are fond of cereals and fruits. The Colobus monkey is threatened by the fact that it is a common delicacy in the area.

- **Wilderbeest**

Although said not to exist in the Tsavo, it can be found in the remote region around Lake Jipe.

Some of the other wildlife occasionally visiting the lake but are not frequently sited by the locals include the following;

- Giraffe,
- Oryx
- Waterbuck
- Buffaloes
- Antelopes and Gazelles
- Leopard (*Panthera pardus*),
- Cheetah (*Acinonyx jubatus*)
- Gazzelle

Residents remember that wildlife used Lake Jipe and water ponds and canals spread around the area as their watering point. Many Hippos lived in the Lake. It is reported that many wildlife animals tend to roam around the village threatening people and livestock as they search for water during the dry periods of August to October. Many of them are unable to access the water in Lake Jipe due to deep sedimentation and *Typha* weed. Water quality is also low - saline, muddy and with bad odor. Hippos have migrated to the lower Lumi River plain and are reported to be causing damage to the riverbank, crops, animals, people in Kimorigho location and surrounding areas.

5.6.2 Avi-Fauna

Lake Jipe has a variety of Avifauna including many Palaearctic migrant waders and Inter-African migrant water birds, whose status on the Lake is not clear. Lake Jipe is one of the few places in this part of Eastern Africa where the Lesser Jacana and the Purple Gallinule are common and where the Madagascar Squacco Heron, Black Heron, African Darter and African Skimmers are often seen. The Pigmy Geese that once used to be common in the 1970s now seems to have disappeared probably due to increased conductivity of the lake.

A complete listing of some of the bird life species found in the Lake Jipe follows below.

- Lesser Jacana
- The purple gallinule,
- The Madagascar squaco heron,
- The black heron,
- The Great Egret,
- African darter,
- Taveta Golden weaver and
- The African skimmers.


Figure 6. Bird life around Lake Jipe

5.6.2.1 Migratory path of birds

Tsavo West National Park forms part of a corridor of natural habitat through which vast numbers of the Palaearctic birds migrate, especially in November and December. These birds include the threatened Corncake and nearly threatened Basra Reed Warbler.

5.6.3 Reptalia/Amphibia

Several reptiles and amphibians can be spotted in the Lake Jipe and the entire catchment. These reptiles and amphibians inhabit the Lake and the surrounding area completing the complex food web that is found in the area. These reptiles and amphibians include;

- **Crocodiles**

They are found in the lake and along rivers Lumi and Ruvu. They mostly feed on aquatic organisms such as fish. Incidences of attack on humans are very few.

- **Frogs and toads**

These are mostly found along rivers and near the banks of Lake Jipe. They feed on small insects in the lake and on land.

- **Lizards**

They are mostly seen on dry land. They feed on insects.

- **Otter**

It's an aquatic animal that feeds on fish and is once in a while spotted in the wetland.

- **Water Lizard**

These are found predominantly in water as its name suggests. They feed on small animals and insects.

5.6.4 Aquatic Communities

The Lacustrine ecosystem provided by the freshwater Lake is joined by the extensive riverine system (Lumi River) that forms the wider Jipe-Lumi floodplain ecosystem. Lake Jipe itself has a swampy littoral zone and a belt of permanent swamp land that extends along the border for 30 km west of the Lake. Another smaller swamp extends southeastwards from the other end of the Lake. It is fed by River Lumi into Kenya while the water flows out through the Ruvu in Tanzania.

5.6.4.1 Fisheries, Fish Communities and Species Abundance

Oreochromis jipe is said to be endemic to the Lake. In the 1960s, Lake Jipe had a booming fishery dominated by *Oreochromis jipe* and *Clarias gariepinus,* with *Barbus sp* and *Labeo sp.* as minor fish stocks.[47] Vehicles transported fish from Kenyan and Tanzanian fish landings to various markets. The fishery attracted a large population of fishermen (the Luo, Taita, and Luhya from Kenya; and the Pare and Chagga of Tanzania). *0reochromis jipe* was later displaced by *Oreochrornis esculentus,* reportedly introduced from Lake Nyumba ya Mungu downstream, when a decline in the fishery was noted. Currently, however, the fishery of Lake Jipe has collapsed and most fishermen and stakeholders in various ancillary services have left the lake. Key issues include:

1. Shrinking of breeding grounds due to siltation of the lake and increased *Typha*
2. Reduced water levels
3. Reduced fish landing (Up to 50% reduction in landings over four years)
4. Reduced table size for landed fish
5. Lack of alternative sources of income
6. Migration to town due to poor economy in the fishery
7. Transboundary wetland management conflicts (Compounded problem related to Tranboundary Natural Resource management)
8. *El nino* effects of – 1997/98
9. Surveillance limited due to reduced resources availability including staffing for the Fisheries Department and KWS.
10. Poorly coordinated beach management (committee)
11. Encroaching swamp/wetland areas for farming

5.6.4.2 Aquatic Macro-Invertebrates

Whereas River Lumi and Lake Jipe are important habitats for macro-invertebrates, no comprehensive studies have been conducted on invertebrates from this ecosystem. It is acknowledged however that this ecosystem has a rich diversity second only to Lake Naivasha.

5.6.5 Rare or Endangered Species

Some species of flora and fauna have been identified and marked as rare and endangered in the Lake Jipe catchment area. These species are briefly described below.

- **Flora**

Afzelia quanzensis (Pod mahogany/Lucky bean tree): This tree, locally known as “Mbamba kofi”, is now sadly rare and deserves extensive replanting. Its timber is hard and durable in salt water, darkening with age and taking a high polish, and is much prized by carvers for doors and furniture and also for dhows and dugout canoes.

Ficus sycomorus (Sycomore fig): This tree, locally known as “Mkuyu”, is becoming rare due to felling for its timber. It is remaining in stands along the river Lumi. The Figs are much eaten by Birds, Monkeys, Baboon and Hyrax.

- **Fauna**

Colobus Monkey: This monkey is a threatened species as its meat is relished by the local community members. Its flesh when eaten is believed to cure many diseases hence it is being hunted at an alarming rate.

African Darter: Small numbers occur at Lake Jipe where they have nested. However, the degradation of the lake environment has resulted to a sharp decrease in its numbers. Another nearly threatened bird species is the Friedmann's Lark, which has been recorded singing and displaying in years of good rains, and presumably nests here.

5.6.6 Sensitive Environments

5.6.6.1 Swamps

The increasing human population in Taveta division is resulting in increased pressure on the available natural resources. Worth mentioning as habitats that are vulnerable due to human encroachment either to create land for cultivation of food crops are swamps, such as the swamp that is being reclaimed at the Kimorigho area. The encroachment of this swamp, which serves as a habitat for Crocodiles and Hippos, has resulted to human-wildlife conflicts. There are reported cases of Hippos attacking the locals and also invading their field crops to feed at night.

5.6.6.2 Forests

Forested areas are also sensitive habitats due to deforestation carried out by some locals and outsiders. Trees are felled for timber, firewood and charcoal burning. These forested areas; such as the Kitobo forest, are home to Monkeys, Baboons, Birds, and Pythons. They also act as catchment areas for the various springs such as the Njoro Kubwa and Kitobo springs that recharge ground water for the entire Taveta area.

5.6.6.3 Water Catchments

Lake Jipe is another sensitive habitat due to siltation and subsequent invasion by the weed *Typha domingensis*. The Lake is a habitat for Hippos, Crocodiles, and various water birds, which include the Lesser jacana, the Purple gallinule, the Madagascar squaco heron, the Black Heron, the African Darter and the African Skimmers.

River Lumi is also a sensitive habitat as its banks are being cultivated and its waters illegally abstracted for irrigation of crops. Hence, the river is being degraded and the flora associated with it, (the indigenous trees *Afzelia quanzensis* and *Ficus sycomorus*), and the fauna associated with it (Hippos, fish, birds, Monkeys, Baboons, and Crocodiles) are threatened.

5.6.6.4 Species of commercial Importance

Worth mentioning is the fish species *Oreochromis jipe* which serves as the main source of protein harvested from the Lake. This fish specie is thus of commercial significance as it contributes to trade in the area.

5.6.7 Destructive species

Fauna

Worth mentioning are the African Elephant *(Loxodonta africana*) which raid farms and destroys crops; and sometimes kill human beings by trampling them. Hippos are also considered nuisance species as they raid farms and sometimes cause human deaths.

Other destructive species include the Crocodiles that have a reputation for causing loss of life or injury as they prey on the communities especially when drawing water or fishing. Crocodiles that are mainly found in the wetland area pose a great menace especially due to their preying nature on livestock and more significantly human beings. They have been known to cause loss of life or injury to the local communities.

Baboons and Monkeys also complete the list for destructive species of fauna. This Ape family of species are a constant headache for the villagers due to their incessant crop destruction**.**

Cheetahs, Leopards, and Lions are sometimes reported to devour the goats, sheep and other animals in the area. These are the stray cats that once in a while move from the Tsavo National Park to the area of study.

Flora

Worth mentioning is the *Prosopis juliflora* which is colonizing bare areas at an alarming rate. This plant out-competes other species where it grows and is of less economic importance to the local community. Despite the fact that goats relish its pods, the thorns are said to be extremely poisonous and termites easily attack its poles. However, the plant has colonized bare areas thus helped to prevent severe soil erosion and it is said to be an excellent source of charcoal.

Typha domingensis is a noxious weed that has invaded the Lake Jipe. It is of less economic importance as it is less palatable to livestock and wildlife such as the elephant. Its reeds are of low quality hence cannot produce quality handicraft. Furthermore, it increases the salinity of the waters of Lake Jipe hence changing the ecosystem.

5.6.8 Pests and Vectors

Theileria parva parva, the vector that causes East Coast Fever (ECF), is transmitted by Tsetse flies and is a menace to livestock herders as it causes ECF in cattle and sleeping sickness to human beings.

Plasmodium falsiparum, the malaria causing vector, is transmitted by the female Anopheles mosquito and causes malaria in human beings.

Common pests in Taveta include the rats, maize stock borers, and weevils.

5.6.9 Structure of Lake Jipe Catchment and its key functions

Lake Jipe emerges as a very significant wetland not only locally but also nationally and even internationally due to the fact that two countries share it. In this regard, the study through direct observation, and review of literature has identified and found out that this wetland and its associated tributaries is capable of and has in essence been providing the following key services and vital functions.

- Ground water recharge in the surrounding areas.
- Ground water discharge as shown by the continuous and stable flow of Ruvu River.

- Flood control as demonstrated by the shape of the basin where direct rainfall, Lumi discharge, Kirurumo River discharge and surface run-off are retained in the basin like shape and released evenly.
- Sediment and toxicant retention; Most of the sediment and some toxicant from farm lands may be retained at the edges where there is weed growth thereby making the open water quality suitable for human consumption. This was evidently so as villagers use canoes to fetch water for domestic consumption about 300m from the shores.
- Water transport; canoes and boats can conveniently be used to transport people between Kenya and Tanzania.
- Recreation and tourism; the presence of Tsavo park and Mkomazi Game reserve in Tanzania; and the Lake itself can offer unique sites for wildlife resource, fishing, hunting, and bird watching.
- Products from the wetland include forest resources, agricultural resources, and fisheries, grazing for livestock, wildlife, foliage and more important water supply.

The Lake Jipe catchment in spite of performing the above key services and functions that remain significant to the population and communities around it, also at the same time plays a very significant role in maintaining a complex food chain and web that remains vital for the survival of the existing flora and fauna.

5.7 Socio-economic Environment

5.7.1 Demography

The total district population according to the last census was as follows: 1962 (90,150,000); 1969 – (110, 742 – 147, 597); 1989 – (207, 273); 1999 – (244, 945). The 1999 census projected a population of approximately 252,000 people by the end of the year 2002. The growth rate is 2.3% per year, a decrease from 2.9 % in the last decade. However, there are variations in the population distribution and in the rates of population change across the district (DSO April 2000).

The average population density in the district is 14 people per square kilometer. However, the Tsavo National Park takes up 62% of the total area in the district. Most people live in the high potential areas of Taita and Taveta, at the foot slopes of the hills as well as in urban centers (see table 7 below). The majority of the population lives in areas between 1,000 and 2,000 m a.s.l, especially in Wundanyi, Mwambirwa and Tausa Division. Some sub-locations in these areas have population densities exceeding 100 people per square kilometer. These high potential agricultural areas have experienced growth rates above the districts average, which has led increasing land fragmentation and land shortage. The result is down- slope migration to the foothills and lowlands, which has occurred over the last 30 years. The population density in the lowlands still does not reach more than 10 people per square kilometer. Five percent of the Taita Taveta people live and work outside the district, mostly in Mombassa and other towns of the Coast province (CBS 1994; DSO April 2000; Were 1986).

Table 7. Population distribution and density in Taita Taveta District

Division / Sub Location	Location	Population census 1999			Urban population (Census 1999)
		Number	Density (Year 2000)	Projection (Year 2000)	
Mwambirwa		4,959	113	6,000	
	Bura	1,660			
	Ronge'e Juu	3,297			
Mwatate		5,892	33	58,000	3,794
	Bura	9,761			
	Chawia	5,783			
	Kidaya/ Ngerenyi	4,094			
	Kishamba	7,042			
	Maktau	7,191			
	Mwachabo	10,744			
	Mwatate	12,265			
Tausa		20,541	66	22,000	
	Ngolia A	6,509			
	Mbololo	5,483			
	Rong'e	5,217			
Taveta		52,142	83	54,000	11,139
	Bomeni	21,385			
	Chala	7,569			
	Jipe	6,183			

	Kimorigo	9,932			
	Njukini	7,073			
Voi		53,316	18	55,000	23,181
	Kasigau	12,148			
	Maungu	7,120			
	Sagala	10,765			
	Voi	23,181			
Wundanyi		55,118	80	57,000	4,293
	Kishushe	4,103			
	Mbale	5,475			
	Mgange	9,642			
	Mwanda	3,811			
	Werugha	8,799			
	Wumingu	9,121			
	Wundanyi	14,167			
National Parks		1,977	0.2		
TOTAL		244,945	14	252,000	

Source: DSO April 2000

The censured population of Taita Taveta district in 1999 was 246,671 out of which 123,329 were men and 123,342 were women. The estimated population for 2002 was 259,889 and comprised of 129,938 men and 129,951 women. The 1999-censured population for Taveta division was comprised of 27,304 men and 25,734 women. The estimated population of the division for 2002 was 55,880 comprised of 28,767 men and 27,113 women (Taita Taveta District Development Plan 2002-2008, GoK, 2002)

Taita Taveta district has one of the lowest inter-censal annual population growth rates of 1.7% as compared to national average of 2.9% and 3.1% for Coast Province. Total fertility rate for Taita Taveta is 4.7 per woman as compared to national average of 5.0 and that of Coast province average of 5.2. Infant mortality rate per 1,000 for Taita Taveta is 62.7 compared to national average of 77.3 and 86.2 for Coast Province.

5.7.1.1 Recent Population Trends and Projections

The population of community around Lake Jipe is said to have reduced from about 6,000 in 1997 to about 3,000 today. Many business people who were trading in fish and related secondary activities have left. Many fishermen have left for gainful employment on farms and towns. Although communities around Lake Jipe are the most affected, the same trend is reported around the division. Many young people who would join thriving business within the division now go elsewhere to look for employment. Tourism has decreased by over 80% and many private tourist lodges and camps in the division have closed. Environmental degradation and ignorance have conspired to cause a vicious cycle of poverty characterised by high child mortality, increased incidences of school drop out rate, diseases and famine.

Interview with stakeholders in Taveta division indicate that the population is decreasing due to various reasons including the decline of fishing and farming activities that have been declining since the El Nino Rains in 1997 that marked a changing point in the environmental, social and economic fortunes of the division. Siltation affected Lake Jipe and the Lumi River delta. Lumi River

broke its banks and flooded adjacent farmlands, changed course and fed into Ruvu River instead of feeding directly into Lake Jipe. Fish types and quantities started to dwindle; Makuruvia weeds invaded Lake Jipe in large large amounts.

It is projected that the population of Taveta Division and particularly that of communities around Lake Jipe will continue to face increased levels of poverty and decline further than it has already faced if the current environmental degradation is not reversed and appropriate action taken for the restoration of Lake Jipe and Lumi River to improve sustainable farming, fishing and alternative livelihood practices.

Ethnic Groups and Cultural Aspects

The most predominant ethnic groups living in the district include (CBS 1994):

- Taita (72%)
- Kamba (10%)
- Taveta (5%)
- Mijikenda (3%)
- Tanzanians (Pare, Chagga etc. 1%)
- Others (Somali, Maasai, luhya, Duruma etc 6.5 %)

Taita and Taveta are the indigenous ethnic groups in Taita Taveta District. They were not he first to inhabit the area. Perhaps the first people to move into Taita Hills were the Wambisha and the Wanyamba. The Wambisha came from the Ethiopian Highland and probably reached Taita in the 9th Century A.D. The Wanyamba were small in size like pygmies and are sometimes referred to as dorobo or ndorobo like (Bravmann 1992 & Mwakio 1996).

The ethnic group of the Taita belongs to the Bantu tribe. They occupy three discrete areas near the coast that can be explained with the fact that the Taita moved around before settling in Taita Taveta District.

When the west Bantu first moved into the area (1000-1300 A.D), they settled at the foot-slopes of the Taita hills (Phase one). Due to continuous conflicts with the Maasai, living in the lowlands, they started moving out of the hills to Shungwaya (south- eastern Somalia) (phase two). There they came into contact with east- Cushitic tribes from Ethiopia. As a result of this period they were described as North Eastern Bantu. Most probably pressure coming from the Galla and Somali leaving in the area or from overpopulation resulted in movements towards “Mwangea wa Nyasi” (Mount Mangea) in Kilifi District (Phase three). Between 1550 and 1670, a part of the tribe came back to theTaita hills after moving around in the surrounding areas (e.g. Pare and Usambara mountains). They first settled at Ngerenyi and then dispersed to all other parts of Taita. Many other tribes, for example the Gueno, Chagga and Pare, claim the Taita to be their ancestors (Bravmann 1992, Etzler 1992 and Mwakio 1996). Bravmann (1992) writes: “ Taita’s a mixture of immigrants from so many different parts of East Africa led to one historian to call it “ a meeting pot of different peoples and cultures’”.

The majority of the Taita live in the high potential area of the Taita hills. They are a relatively homogenous ethnic group that can be divided into three groups (Were 1986).

- Dawida (majority), living in the Taita range, containing the Dawida and Mbololo block
- Sagala, living on the ridge of the Sagala range
- Kasigau, living around the Kasigau range

The Taita are a friendly community, living in peace and stability. They practice farming and grow mostly maize, cassava, sweet potatoes, pumpkins, beans and cowpeas. Typical for the Taita is their agricultural strategy as they always had access to and used land in different ecological zones during different seasons to make better use of the two rainy seasons for farming and grazing. They additionally used to trade with wildlife meat. All the community utilizing the Tsavo plains had their own traditional way of wildlife management. The clans were careful about depleting wildlife on the land. The Taita had a system of taboos that protected wildlife from uncontrolled hunting. After an animal had bee killed the meat would be cut carefully and cut into strips and dried so that it would last for more than three months (Mwakio 1996 and Were 1986).

Famines and drought have had a great impact to the Taita population. In the 1850's famine and during the drought of 1883- 1886 that swept the Taita hills and plains, at least a third of the human population died. Due to the drastical decimation of the population and movements out of the hills, bush encroachment took place having a great impact on the land use patterns in the district, especially on agriculture (Mwangi & Mwangola 1998).

The Taita are traditionally found in the high potential areas of the Taita hills but have also settled in the transitional zones and the lowlands around the hills and in Taveta sub- district. Traditional religious and social practices are dying out due to increasingly Christianized generation with modern education. Receptiveness to new ideas and a positive attitude to development are values that are in progress. Respect to elders and co-operation in cattle herding and other main tasks are traditional values that are still strong (Were 1986).

The Taveta are the indigenous group in Taveta sub –district, occupying the original forested area adjacent to the Lumi River. They are a minority group in their own area constituting less than 25% in Taveta sub –district. (Were 1986)

There is very little and mainly contradictory information available (in literature) about the Taveta as an ethnic group. They speak a different dialect from the Taita and feel that they are a separate ethnic group (the same goes for the Sagala) though this has not been proven (Mwakio 1996, 50). However, even if they originate from the same tribe, significant differences can be noted between the two groups. The Taveta's are a coherent group with a strong sense of their own culture and identity but they are surrounded and infiltrated by immigrant people such as Taita, Kamba, Luo and Luhya. The result is that Taveta is a multicultural region and the Taveta seem to be open to this as they contribute to infiltration by selling land to strangers. Due to this, their existence as a separate racial group seems to be threatened (Were 1986).

The Maasai are a typical, and maybe the best-known, pastoralist group in East Africa, living in wide area of the lowlands of Kenya and Tanzania.

The Maasai have roamed he plains surrounding Kilimanajaro, pare, Taita and Usmabara Mountains for many years (Bravmann 1992). They keep mixed herds of cattle, sheep, goats and

some donkeys in numbers sufficient for subsistence, security against droughts and disease, social obligations and to be sold to raise cash. The most important animal though is the cow which gives milk, a staple food of the Maasai. Due to population pressure and land privatization "the majority of pastoralists no longer have the land or flexibility of movement to support themselves from their livestock alone. Inadequate pricing and marketing systems for livestock have made it necessary for pastoralists to adopt other means of livelihood". (Berger 1996). There is little support in Taita Taveta district for the Maasai. For instance, there is no school or access to domestic water in the Salaita area even though the Maasai have settled there since they emigrated from the Rombo area of Kajiado district in 1907 (Maasai community meeting 14-04- 2000). The Wakwafi, a group of agriculturally oriented Maasai, came to settle in the highlands around 1830.

One community, that was mainly dependant on the Tsavo ecosystem, was the Wariangulo, akin to the Ndorobo. These people lived in groups of 10 to 15 adults. They used to be hunters and gatherers, living on meat, fruits and honey from the Tsavo plains. The gazettement of the Tsavo National Parks confined their territory to government land and trust land. At the same time people moved from the hills into the lowlands because of the increasing population. They were not capable of adjusting to the pressure and ended in urban centers i.e. Voi town where they suffered social disintegration, as they were not used to cultivating crops (Mwangi & Mwangala 1998).

Of the other numerical important groups, many Kamba came and still come to settle in Taveta and the drier, less densely occupied area of Taita, especially around the Kasigau areas. Many Duruma and Mijikenda have settled between Buguta and Maungu where they have outnumbered the indigenous Taita. The Luo and Luhya are mainly found in and around the sisal plantations (Taveta, Ziwani, Mwatate and Voi) where they are or used to be employed. They are temporary residents that still regard western Kenya as their home. Other tribes are mainly found in urban areas, especially Voi and Taveta and in the mining areas. There are an increasing number of the Somali community leasing ranches in Taita for keeping livestock. In Taveta sub- district, they are dominating the business sector, especially the cross- border business (DSO April 2000 & Were 1986).

5.7.1.2 Tribal Affiliations, Co-Operation and Conflicts

There is a relative harmony and goodwill between the different ethnic groups found in the district. This can, in part, be traced back to the historical socio- cultural attributes of the Taita and the Taveta communities, which not only encouraged co- existence but also had clear traditional rules over resource utilization. However, these rules are gradually being eroded away (Were, 1986).

The younger generation has been heavily exposed to the socio- economic and cultural changes in the country and the world in general. Consequently, they are more tolerant towards others- both from within their group as well as outside. However, unlike elsewhere in the country, inter- cultural marriages are still not common amongst the Taita. The cosmopolitan population in Taveta sub-district, unlike the Taita community, are more open to new ideas, technologies and innovations in general (Were 1986).

Natural resources and, in particular, land are a primary basis for conflicts in Kenya. For example, a potential problem over land exists in Taveta where there is a large squatter population and land speculators. Although the government usually gives limited land user rights to squatters, the problem in Taveta is compounded by the fact that there is no public land in the sub- district. In the

few settlement schemes in the district, which give priority to local people, land allocations have often led to conflicts (DLASO February 2000).

Some conflicts exist in the use of forests and forest products. The communities have little access to most of the gazetted forests. Limited use is permitted for example in the Kitobo forest for collection of dead firewood and building materials for community projects e.g. schools and churches. It has, however, been recognized that the complete exclusion of the communities in the management of these forests has aggravated their deterioration. There is great potential for the non- destructive use of forests e.g. eco-tourism, bee keeping and collection of medicinal herbs. There are ongoing initiatives in the district geared towards sustainable utilsation and joint management of these forest resources.

A major conflict remains between humans and wildlife, especially in communities living adjacent to protected areas. The Kenya wildlife service (KWS) has run programmes addressing the human-wildlife conflict. Unfortunately, the initiatives have so far been grossly inadequate due to many external factors e.g. logistics, financing, policies etc. some of these problems are beyond the control of KWS.

Conflict based on land use exists mainly between the Maasai and other communities in Taveta Sub- district. When the Maasai settled in Salaita area in the 1970s, they brought large herds of livestock with them which resulted in severe soil erosion and land degradation due to overstocking. During the dry period, the Maasai graze their livestock towards Lake Jipe thereby competing for grazing and water resources with the rest of the communities. Since the establishment of he lake Jipe settlement scheme (in 1996), the conflict in the area has risen dramatically due to the loss of the last and most important grazing area of the Maasai community. The Maasai have been instrumental in opposing the erection of an electric fence along the park border between Lake Jipe and Njukini for fear of loss of grazing opportunities in the park. The effect of this has been an escalating human wildlife conflict for farmers in the area.

The provincial administration, through the local elders and the law enforcement agencies, is responsible for conflict prevention and resolution. Potential issues of conflicts are usually addressed in public meetings (Barazas). The courts of law are always the last resort to settle disputes (City Council Taita Taveta April 2000).

5.7.2 Land Use and Tenure

Taveta Division has a total of 16,959 hectares of land out of which 1,936 ha (11%) is arable, 4,057 (24%) is rangeland, 10,539 (62%) is under National Parks and 449 (3%) is under covered by rocks and water.

It is estimated that over 75% of land within Taveta Division is owned by two individuals (Taita Taveta District PRSP Consolidation Report for the Period 2001-2004). Part of the remaining 25% is demarcated and protected state land under wildlife conservation within Tsavo West National Park. Another part is clan land whose adjudication and demarcation started in 1985 but has not been completed for issuance of title deeds to individuals. The different areas being adjudicated are Kimorigho, Mbogoni, Kimalamata and Kitobo. Kimorigho and Mbogoni are in the final stages of

adjudication while the remaining two are in the initial stages. There is one settlement scheme in the area that was obtained from one of the large-scale landowners.

5.7.2.1 Existing Patterns of Land Use

Taveta Division covers an area of about 645,000 sq. km comprising five administrative divisions of Jipe (181,000), Kimorigo (154,000), Bomeni (76,100), Chala (145,300) and Njukini (72,000). (District Development Plan 2002).

Two individuals privately own about 3/4 of the land in Taita Taveta division. Part of the remaining 1/4 of the land is State Land which is under the Central Government part of which has been adjudicated into the Jipe Settlement Scheme to settle a cosmopolitan population. The Scheme is beset with a number of problems resulting in inability to settle 60% of the intended beneficiaries because of planning problems caused by inadequacy of resources. The other part is Trust Land under the trusteeship of Taveta Town Council. Trust land is usually set aside for registration as private land through ancestral ownership and also for public utility areas such as hospitals, schools, plays grounds, *etc.*

Adjudication of Trust Land in Taveta Division started 20 years ago and is continuing. There are four land adjudication sections. These sections are Kitobo and Mbogoni, Kimorigo and Kimalamata. The latter two are in the final stages of registration, which was expected to be completed by the end of 2004. Riparian lands have been encroached and demarcated for private ownership. These include swamps around Lake Jipe and The Lumi River bank. Land officials are aware of existing legislation against such encroachment - including EMCA which require that a 10 metres buffer zone from a river bank be set aside - but have not complied.

Problems arising from delay in the adjudication, demarcation and issuance of title deeds have been widely discussed by stakeholders who note that "over 75% of the area land is owned and controlled by two individuals. A huge amount of land under sisal plantation does not benefit the local people much. Sisal growing is mostly at the expense of local food needs. Farmers are unable to fully exploit land resources because most are squatters (and therefore most) farmers are unable to raise their children's school fees, resulting in increasing levels of illiteracy among youth, diminishing employment opportunities and a high dependency ratio compounded by the HIV/AIDS menace which takes its toll on the most productive people. Poverty in Taveta division is very severe affecting over 60% of the people" (Republic of Kenya: Taita Taveta PRSP Consultation Report for the Period 2001-2004). The report concludes that the Government needs to, *inter alia*, hasten the process of land adjudication, demarcation and issuance of title deeds, arrest land grabbers, allocate squatters land where they are based and repossess unfairly allocated plots

The following are the main land use activities within Taveta Division.

- Wildlife Conservation under KWS and community initiatives
- Large scale farming, mainly sisal and horticultural crops under private land
- Idle land mainly under private ownership and some ancestral land
- Small-scale farming, mainly subsistence crops and horticultural crops for local market
- Large scale livestock keeping, mainly beef cattle, goats and sheep in private individual ranches and group ranches

- Medium and small scale livestock keeping, beef and dairy cattle, goats and sheep on individual plots and within the rangelands.
- Fishing, mainly on Lake Jipe, River Lumi River and in shallow wells and canals
- Mining
- Forestry
- Charcoal burning

Table 8. Land Use Patterns

Item	**Details**
Agriculture	
Average farm size (small scale)	0.4 Ha
Average farm size (large scale)	4.8 Ha
Main food crops produced	Maize, beans, cassava, cowpeas sweet potatoes, pegion peas, green grams, horticulture, crops
Main cash crops produced	Sisal, coffee, macademia, cotton, coconut horticulture crops, oranges, mangoes and bananas
Total average under food crops	14,399 Ha
Total acreage under cash crops	4,037 Ha (excluding sisal estate)
Main storage facilities (on and off farm)	Improved granaries and traditional stores
Population working in the agriculture sector	113,846
Total number of ranches	25
Average size of ranches	12,762.5Ha
Main livestock breed	Dairy and beef cattle, goats, bees, poultry
Land carrying capacity	22 animals per Ha
Population working in the livestock sector	2,250
Main species of fish catch	Tilapia, mud fish and sardines
Population of fish farmers	158
Number of fish ponds	185 (119 operational, 54 inactive, 12 new)
Number of landing beaches	5
Number of boats	54 boats and 6 rafters
Number of farmers having title deeds	4,138
Size of gazzetted forests	11.18Km^2
Size of non-gazzetted forests	91.65Km^2
Main forest products	Timber construction materials, Herbal drugs
Percentage of people engaged in forest related activities (saw mills, furniture works)	5%

Source. Amos Otieno Nyangwara, & Kirianki M'Imanyara, 2004

The above land ownership and land use patterns have resulted in various negative environmental consequences, some obvious and others that need to be ascertained. These include:

- Deforestation and loss of vegetation cover as a result of overgrazing, cutting timber, cutting down trees for charcoal
- Soil erosion as evidenced by downstream siltation, bare soils, deep gullies, etc caused by overgrazing, cutting down trees, inappropriate farming practices, river diversions
- Water catchment degradation caused by cutting down trees, farming, grazing livestock within the catchment, and other human activities
- River bank destruction through legal and illegal diversions
- Loss of readily accessible traditional forms of household energy sources
- Pollution of river water from use of chemical pesticides for crops
- Lowering levels of water in Lake Jipe
- Lowering levels of water in springs and rivers
- Increased levels of poverty and loss of livelihood in communities

5.7.3 Resource Utilization Patterns and Trends

5.7.3.1 Agriculture

A big proportion of arable land in Taveta Division is used for agriculture, most of the arid part for sisal farming, ranching and National Park. The sisal estate has been abandoned and squatters have uprooted most of the crop leaving the soil bare and more vulnerable to soil erosion and siltation of the Lake Jipe and Lumi River. It is estimated that 40% of wetland area has been reclaimed for farming through draining. Some of the arid lands are now under irrigation. Absence of environmental protection programmes, the thin and loose sandy / loam soils, sparse vegetation cover, overgrazing of livestock, charcoal burning and inappropriate farming practices in upper parts is cited as the main cause of land degradation, soil erosion and sedimentation downstream. A fast-growing, fast-spreading thorny shrub locally known as mrachi that was introduced around 1980 is said to be the main hope for reafforestation efforts. It is said to be useful in providing vegetation cover, wind and dust break, fuelwood, animal feed especially for goats and sheep. It is good for vegetative soil cover to slow down soil degradation and erosion and siltation into Lake Jipe and Lumi River. However, local communities report that the mrachi has certain disadvantages because it has sharp, poisonous thorns and suffocates growth of other vegetation around it.

Most farmers around the division grow maize, beans, and green grams. Those who access water for irrigation grow horticultural crops such as tomatoes, onions, green vegetables among others that they supply to the local markets, such as Mombasa and Voi. It is alleged that a few people have established illegal abstractions of water either for irrigation of the semi arid parts of the farmlands, or to drain to the lower marshlands for farming. However, many people in the community are ready, willing and committed to the restoration of Lake Jipe and the Lumi River flood plain ecosystem. Many community initiatives in this direction were witnessed on the ground but they need further opportunity and support on a wider scale and sustained basis to cover larger sections of the affected areas more effectively.

Land use is such that the better soils have been allocated to sisal estates. Most of the small-scale farmers, growing a wide variety of crops have their plots on saline and sodic soils. Even the areas allocated to the irrigation schemes named above have larger portions of saline and sodic soils.

Bananas are mostly grown in swampy areas and other areas adjacent to the river Lumi, where the ground water table is fairly high. These are highly valued both as a staple food and as a cash crop. Bananas from Taveta are of good quality and generally fetch high prices. Maize and beans are grown for food. Maize is as much valued as a food crop as the bananas. Other crops include cowpeas, vegetables, oranges, coconuts and mango trees. Generally, the levels of inputs and husbandry are low. This together with below optimum rainfall sometimes results in poor yields.

Of the thirty-one schemes in this area only a few are operational. A majority of schemes, which were developed years ago, are either partially operational or abandoned. The reason for abandonment of these schemes has been floods, water logging and development of salinity /sodicity problems. Major crop agricultural activities are centered on irrigation schemes utilizing Njukini, Kitobo, Njoro, and Lumi springs. The irrigation schemes include Chala, Kasokoni, Kitobo, Majengo, Kamleza, Kimundia and Kimorigho schemes. The schemes produce horticultural and subsistence crops.

The following table shows the main socio-economic activities in Lake Jipe and their environmental impacts especially with regard to the lake ecosystem. The lake has a high development potential whose realisation is hampered by poor access. This is the case especially for tourism with very few visitors reaching the lake despite its huge concentration of wildlife especially Hippos, Crocodiles, Waterbirds, Elephants, Zebras, Impalas and Gazelles. The table shows that most of the negative environmental impacts emanating from human landuse are concentrated within the northern and northeastern areas of Lake Jipe especially areas around Ziwani. Irrigation activities in the Ziwani area have collapsed in the last ten years as a result of a major shift in the flow direction of the Lumi River, which instead of flowing into the Lake is now discharging almost directly, into the Ruvu River. This transformation is probably caused by silt deposition at the floodplain, which is also said to be the cause of the collapse of small irrigation activities due to permanent flooding in the farms.

Extensive small-scale agricultural activities, poor land management system and a slightly sloping, exposed topography has highly contributed to soil erosion. Deep and wide gullies are a common feature in the area- and the top fertile soil loosened during cultivation is continuously being swept down into the lake Jipe through numerous channels. Soil conservation is not common practice in most farms and in the few places where it is practiced it is on-farm and limited in containing the problem.

Owing to the high agricultural potential and this coupled with steep slopes, serious soil erosion is taking place. Effect of high velocity runoff has immensely degraded the land. Deep and wide gullies are a common feature in the area-and the top fertile soil loosened during cultivation is continuously being swept down into Lake Jipe through numerous channels. Soil conservation is currently on- farm and is limited in its effectiveness to contain the problem.

5.7.3.2 Livestock Activities

Water is a problem in the northern part (Challa) especially during the dry season forcing livestock to be moved toward Kimorigo and Lake Jipe area. With wider seasonal variation in quantity of water and pasture there is the increasing influx of livestock from the neighbouring district of Kajiado. The combined effect of overgrazing and livestock trekking is the partial and complete removal of vegetation cover leaving the soil bare. Sheet and wind erosion are greatly enhanced by

this unchecked livestock land degradation activity, the overall adverse result being the increased silt load in the run- off water from the affected area of the catchment.

Statistics from DLPO Taita Taveta indicate that most of livestock brought to auction rings is not sold. For example in 1994 out of 387 cattle brought to one of the auction rings in the area, (Chumvini) only 69 were sold. During the same period, only 923 goats were sold against 2,433 brought for auction.

Studies done indicate that the catchment areas holds 37,877 cattle and 40,277 goats and sheep. Livestock farming is still practiced along traditional lines. Livestock are trekked far and wide in search of water and pastures.

5.7.3.3 Fishing

The Jipe wetland was once a haven of commercial and subsistence fisheries. There were up to 40 villagers who depended on the Lake for protein supply in form of fish. The fish was supplied by about 40 fishermen who were located in three fishing villages along the eastern edge of the lake namely Kilometa Saba, Kachero and Mkwajuni each of which had a gazetted landing beach.

The fishing gear that was in use at the time included fishing nets, line hooks, sardine traps and other traditional traps such as migono. The main fish types found in Lake Jipe are Tilapia Sardines and Clarias (Barbel fish).

Local people remember that about 7 years ago, there were many types of fish and the smallest fishing net-size allowed for fishing was 4 inches. There were over 200 fishermen, 100 fish traders and over 500 other traders involved in secondary business that supported fishing - transportation, packing, food, accommodation, tourism, and entertainment. Fish types, fishing activities and fish trade in and around Lake Jipe and Lumi River are said to have decreased by more than 90% over the last 7 years. The main reason given is sediment blockage that has caused diversion of Lumi River making it drain directly into Ruver River instead of draining directly into Lake Jipe. This has resulted in the siltation of the Lake, low Lake water circulation (stagnation), invasion of the *Typha* weed, increased salination, change of temperature and low quality of Lake water. This has created an unfavourable environment for fish breeding, fishing, sailing, swimming and use of Kenyan side of Lake Jipe waters by humans and animals as was the case in the recent past. Most of the fish found on the silted shallow side of the lake produce small sized, worm-infected fish. The part of the lake that is protected under the Tsavo West National Park and is said to be less silted and deeper, contains larger and more fish types.

The industry is currently recovering owing to the steady increase in the level of the lake. However the communities that benefit more from fishing are weary that the farming community adjacent to Lake Lumi and Njoro springs is still diverting water for irrigation and this is interfering with the water level and quality of the lake. Note the difference in water colour in the figure 8 below. Water along Lumi is very brown an indication of a high silt load from upstream.


Figure 8. River Lumi meeting with water from Njoro springs.

5.7.3.4 Woodland

A large part of Taita Taveta is covered by a variety of deciduous bush lands and thickets with a few scattered trees. Prevalent trees are the *Acacia mellifera* and *Acacia Tortilis* and *Prosopis Juliflora* that are slowly but surely colonizing the area. The seed pods and leafs from these trees are known to be nutritious to goats hence the preference by the herdsmen of this area of the catchment.

Further due to population pressure, there is the systematic destruction of vegetation to satisfy demand for fuel wood and timber and the expansion of farmlands. Charcoal burning in the area is mainly done for financial gains, as there is plenty of fuel wood within, this poses yet another environmental problem.

It is envisaged that the solution to most of these land degradation activities could be achieved by improving agricultural practices (agro-forestry) to go hand in hand with enhanced soil conservation measures.

5.7.3.5 Mining and Sand harvesting

Gemstone mining is very limited in the area and only a few pits are found within the basement rock areas of the catchment. A provision on part of the prospector exists whereby the mined-out area is supposed to be rehabilitated. The Mines and geology department is the policing agent, but it is noted that the follow up is not effective. The regulation requires that the prospector lose his Kshs.2000/= deposit if no rehabilitation is done.

Quarrying of the 'Challa building stone' a tuffaceous grit and sand harvesting is evident along the waterway and the riverbanks and also in the Salaita and Mate area. These activities pose the following problems:

- Quarrying loosens the soil hence exposing the soils further to run-off water.
- Small broken stones that are left are washed away by the run off water and further assist soil erosion by their attrition action.
- Scooped out sand pits and depression accelerate upstream immediately on the fringes of the pit.

Water Supply

Taveta division is a water-deficit area and ecologically falls under the category of Arid and Semi Arid Land (ASAL). Water supply in Taveta comes from both surface and underground sources.

The various hills in the district are source of streams and springs providing water for domestic and livestock consumption. Water availability in the district varies significantly between the highlands and the lowlands. While water acessiblity in the highlands for the majority of the population is within distances of less than one kilometer, the distances increase between two to three kilometers in the drier ASAL areas (MPND 1996).

Geological studies have indicated that Lumi, Voi and Mwatate River basins have potential for economic water based projects and are suitable for livestock, humans, wildlife, irrigation, fisheries, and industrial needs as well as for electrical power generation (MPND 1996, 209). It has often been stated that agriculture in the transitional and lowland areas could be greatly enhanced if water for irrigation was provided. Feasibility studies have been carried out, i.e. to bring water as far way as Lake Challa to the Kishushe area, over 100 Km away. None of these proposals have been implemented, primarily because of the related, prohibitive capital costs (DWO April 2000).

Surface water supply for Taveta division comes from:

- Lumi River whose source is Njoro Springs within Kimorigho Location and Lumi Springs from the foot of Mt Kilimanjaro in Tanzania and,
- Lake Jipe, which is a fresh water Lake
- Grogan Canal
- Muguru Canal
- Several legal and illegal drainages from Lumi River

Small dams can be found in the district, particularly in the ranches, e.g. Mramba and Lualenyi Dams. Mwatate or Kishenyi Dam for instance are larger dams for domestic purposes. Dams inside the protected areas, like the Aruba Dam in Tsavo East and Bura Dam are for wildlife only and cannot be tapped for domestic use. Most of the dams contain water all year round and the quality is fairly good due to the refreshment of water by means of the sandy riverbeds. This groundwater can be reached by digging, as practiced by men and animals. Pans, Laggas and dams are another source of water for the animals, but only during the rainy season.

Taveta sub district has a groundwater table and substantial water resources due to its proximity to Mount Kilimanjaro. The rainfall at the slopes of Mount Kilimanjaro is often heavy and run- off is high causing floods, which are a menace to roads, bridges and irrigation projects (MoW 1990).

The outlet of the fresh water Lake Jipe, south of Taveta sub district, is River Ruvu that has the Lumi delta and Ruvu swamps as sediment traps. There has been a major change in the nature of Lake Jipe and its wetland in the last 40 years. The swamps have spread into the open waters and there has been an increase in alkalinity or sodic content of the water due to overgrazing and deforestation. This has resulted in severe erosion and has led to heavy siltation of Lake Jipe leading to serious encroachment of reeds and floating islands.

Poor drainage, high evaporation rates, soil textures, salinity etc. in some parts of the district limit the extent to which groundwater can be exploited for domestic use, livestock and irrigation. The groundwater availability is variable as a result of a varied geological nature of the rocks. In Taveta the groundwater table is high (Krhoda 1998). Several springs in the district are threatened due to an inappropriate spring protection; livestock is grazing and watering along and inside riverbanks and springs, which leads to destruction.

Efforts to sink boreholes and shallow wells were made, but, due to the different levels of groundwater, some have to be deep and in effect are yielding tool little water or water which is saline. For instance, only the boreholes sunk near the riverbeds yield enough water of drinking quality. Private companies (sisal estates, hotels), some ranches and individuals use boreholes and shallow wells as their major source of water. In general, many of these water sources are abandoned or dry due to operation and maintenance problems (see table 9 below). There are several unfinished projects, where wells have been established, but, due to lack of capital, they have not been supplied with pumps

Underground water supply for Taveta division comprises of:

- 150 shallow wells of less than 3m deep
- 4 boreholes (only 1 is currently working)
- Several underground drainages from Lumi River

Table 9. Status of boreholes and shallow wells in the district

Division/ sub-District	Number Operational	Number Dry	Number Saline Water	Number Abandoned	Total
Boreholes data					
Mwatate	10	12	13	23	54
Taveta	2	1	0	4	13
Voi & Tausa	6	4	2	11	24
Wundanyi	1	0	8	9	10
Total	19	17	23	**47**	101
Shallow wells data					
Mwatate	6	2	0	-	8
Taveta	47	23	2	-	70
Voi & Tausa	10	2	0	-	12
Wundanyi	5	2	0	-	7
Total	68	29	2	-	97

Source: DWO April 2000

The major problem with water supply in Taveta division is siltation of Lumi River, the canals and Lake Jipe. Siltation has caused blockage of Lumi River course diverting to Ruvu River in Tanzania resulting in the lowering of the water in Lake Jipe. The blockage also causes flooding of Lumi River making farming in surrounding farms difficult. Water diversion from Lumi River is caused by several factors including siltation, Hippos and deliberate human activity to obtain water for irrigation farming during the dry season.

The muddy silt and lack of water inflow into Lake Jipe has resulted in weed infestation, low water circulation, rotting of lake fauna and flora, dirty and smelly water, low aeration, high temperatures and an overall poor climate for breeding of aquatic life and utilization of Lake water by animals, birds and humans.

The Government of Kenya has adjudicated and demarcated land (allocated) for individual ownership and utilization along the Lumi River floodplain up to the swamp near Lake Jipe. Some of the people interviewed fear that this individual / private ownership of riparian lands will make it very difficult for community and government efforts towards sustainable restoration Lake Jipe-Lumi River floodplain.

5.7.4 Water Use

Currently the largest single important use of the water resources in the Lake Jipe watershed is irrigation. While about 7000 ha of land is available in the Taveta area the exact acreage under irrigation is not known. The amount of water currently abstracted for use in the smallholder irrigation schemes is also not known. Besides irrigation, the springs, Lumi River and Lake Jipe are sources of water for livestock and wildlife.

Water for the irrigating the schemes in Taveta is supplied through canals. As a result of financial constraints, many of the canals and other facilities are in poor condition. Due to high groundwater table, poor drainage of some soils and capillary salinisation some irrigation areas have been abandoned like some parts of Kimorigo and Kamleza irrigation schemes (Mugwanja 1997).

In the district various partners are involved in the water sector. These include the National Water Conservation and Pipeline Corporation operating and maintaining the gazetted water supplies including Lumi, Voi, Maungu- Buguta, Debwa- Wusi, Wundanyi- Wesu and the Mwaji- Kateri Water Supplies. The department of Health supports spring protection activities.

Table 10 below is a summary of the socio-econmic activities in Taveta Disision and their environmental impacts.

Table 10. A summary of socio-economic activities and environmental impacts (trends)

Activity	**Description and concentration area(s)**	**Magnitude & significance**	**Environmental impact**
Agriculture	Subsistence farming in the Lumi catchment and lower riparian area. This includes large-scale sisal production.	2	Accelerated soil erosion & sedimentation,
Small-scale irrigation	Subsistence and commercial irrigation in the lower riparian area	1	Impairment of hydrological systems, changes in water discharge and flow rates, lake surface area, water depth, water storage, water pollution and eutrophication
Large-scale irrigation	Commercial irrigation in the lower riparian area	2	Impairment of hydrological systems, changes in water discharge and flow rates, lake surface area, water depth, water storage, water pollution and eutrophication
Rural settlements	Kacheru and Mikocheni lake shore fishing villages, northern irrigation communities, scattered pastoral settlements	1	Negative changes in water quality including accelerated soil erosion and siltation, waste disposal and wetland contamination, resource over-consumption, overgrazing, river damming, loss of species, invasive species especially *Prosopis julliflora*, water pollution & eutrophication, illegal cross-border trade, cross-border resource utilization conflicts.
Urban settlements	Taveta town and other small urban centres to the northern area of the lake	1	Changes in water discharge and flow rates, lake surface area, water depth, water storage, water pollution and eutrophication, introduction of invasive species especially *Prosopis julliflora.*
Livestock husbandry & grazing	Northern and northeastern areas especially around Ziwani area.	2	Resource over-consumption, overgrazing, soil erosion and sedimentation, desertification, loss of species.
Mining	Mainly sand harvesting along the riverways especially River Lumi and tributaries	1	Impairment of hydrological systems, landscape alteration, accelerated soil erosion and siltation.

Forestry	Northern and northeastern areas especially Ziwani.	3	Introduction of invasive species especially *Prosopis julliflora*.
Water supply & water harvesting	Northern and northeastern areas especially Ziwani.	1	Impairment of hydrological systems, changes in water discharge and flow rates, lake surface area, water depth, water storage, water pollution and eutrophication.
Flood control, drainage & dyking	Northern and northeastern areas especially Ziwani.	1	Impairment of hydrological systems, changes in water discharge and flow rates, lake surface area, water depth, water storage, water pollution and eutrophication, landscape alteration, river flow alteration and changes in river direction.
Dredging & channelization	Northern and northeastern areas especially Ziwani.	1	Impairment of hydrological systems, changes in water discharge and flow rates, lake surface area, water depth, water storage, water pollution and eutrophication, landscape alteration, river flow alteration and changes in river direction.
HEP generation	Ruvu River, Tanzania	2	Impairment of hydrological regime, downstream ecological changes.
Commercial fishing	Tanzanian part of Lake Jipe and un-protected part in Kenya.	2	Over-exploitation of fishery resources.
Subsistence fishing	Tanzanian part of Lake Jipe and un-protected part in Kenya especially at Mkwajhumi, Kacheru and Mikocheni	1	Over-exploitation of fishery resources.
Sport fishing	Isolated areas of the lake.	3	Unknown
Macrophyte utilization	Riparian shores in Tanzania and unprotected shores in Kenya	1	Over-exploitation of resources (90% of houses at the Fishermen Village with macrophyte roofing), trampling, overgrazing, burning, introduction of new species including invasive species *Prosopis julliflora*, water quality changes, habitat fragmentation and alteration.
Wildlife	Riparian areas in Tanzania and	1	Human-wildlife conflicts especially hippos and

utilization	unprotected areas in Kenya		elephants.
Nature photography	Isolated areas around lake.	3	Unknown
Bird watching	Isolated areas around lake.	3	Unknown
Boating & canoeing	Isolated areas around lake.	3	Unknown
Camping	Isolated areas around lake.	3	Unknown

Note: (1 = widespread and highly significant, 2 = common and moderately significant, 3 = rare and insignificant)
Data Source: Bear, L.M. (1955) and GoK-JICA (1992)

5.7.5 Wildlife and Tourism

The Jipe catchment includes an area up to 10 km to the east of the lake edge, half of which is in Tsavo West National Park. This part of the catchment including the Jipe wetland is home to various species of wildlife i.e., the Elephants, Lions, Greater Kudus, Baboons, Monkeys and Dik Diks.

Tourism on the Lake and the attraction of wildlife to the Lake has enhanced tourism on this part of the park and as a result a number of tourist facilities have been sited in the Lake neighborhood. These include the Lake Jipe Lodge and Bobby's Tented Camp.

However, the wild animals especially the elephants and lions sometimes conflict with the locals. Lions attack and kill livestock and human beings while Elephants destroy the crops and farms of the locals to the point where it has hindered them from farming. This has greatly affected the food availability and incomes of the local population at the villages e.g. Kachero village.

Some local community members hunt the Colobus Monkey for its meat, which is believed to contain medicinal substances that cure diseases such as diabetes.

5.7.6 Public Health Issues

The communities in Kachero village lack basic infrastructure such as a dispensary, clean water among others. Thus in-case of sickness one has to walk to mata centre that is a 10 kilometres away and to worsen the situation they don't have efficient means of transport. The most common diseases around Taveta area include Typhoid, Malaria, and Dysentry, with Typhoid being a menace due to water pollution.

5.7.6.1

Below is a tabulated highlight of the health facilities present in the Taita Taveta district.

Table 11. Health facilities in the whole of the district

Health Sector	
Most prevalent diseases	Malaria, URTI, Diarrhea
Doctor/patient ratio	1:37,778
Number of health facilities	
Hospitals	3
Health centres	7
Dispensaries	25
Number of private health clinics	-
Mission	4
Private clinics	50
Average distance to the nearest health facility	5km
Nursing homes	1

5.7.7 Sanitation Management

The study area is characteriesd by the use of pit latrines as a means of disposal of human waste in the rural area while the Taveta town has a mixture of septic tanks and pit latrines respectively. The sanitation coverage is recorded to be an impressive 94% in the district. (MoH 1998)

5.7.8 Transport and Communication

The means of transport mostly used is bicycles, trucks for transporting produce, personal vehicles, and buses, donkeys that carry luggage and on foot. Institutions such as banks, postal services, telecommunications, and health facilities are in the town centre, together with an open-air market. Water vending is done at Mata. The road network in the district is fair. However most of the population doesn't have readily access to credit and this could be a hindrance to rapid development.

The area is well covered by infrastructure. A railway line from Voi to Moshi passes through Taveta town. An all weather road (loose surface) from Taveta town to Voi exists as transport infrastructure. A telephone line passes through Taveta to Voi and Moshi. See table 12 below showing the infrastructure and communication facilities in Taveta division.

Table 12. Transportation Infrastructure in Taveta Division

Transport Facilities in Taveta Division	Km
Bitumen	151.8 km
Gravel	311.3km
Earth	491.4 km
Total length of rail line	203.9km
Number of railway stations	14
Number of air strips	4
Number of water ways	-
Number of public service vehicles	60 matatus, 50 taxis, 5 buses, 20 pickups, over 50 buses pass through Voi daily to and from Mombasa
Communication	
Number of households with telephone connection	1,089
Number of private and public organization with telephone connection	1,048
Mobile phone service coverage	35%
Number of sub-post office	19
Number of telephone routes	289
Number of households without radios	-
Number of cyber cafés	6
Trade, Commerce and Tourism	
Number of trading Centers	148
Number of Hotels	76
Number of tourist class hotels	10
Mani tourist attractions	Wildlife, scenery

Number of registered hotels	16
Number of registered companies	17
Number of licenced business	830
Number of informal sector enterprises	-
Minerals	**Precious stones, garnets, Tourmaline, industrial minerals and others.**
Banks and Financial Institutions	
Number of banks	1(KCB)
Volume of credit provided	Not available
Number of other financial institutions	2
Volume of credit provided	Not available
Number of micro finance institutions	5
Volume of credit provided	Not available

5.7.9 Cultural and Historical Resources

There are many cultural and historical resources and landmarks in the Taita Taveta district. Some are cultural and are used for traditional spiritual rites and rituals. Others are historical landmarks put up during colonial period.

Table 13. Cultural and historical resources and landmarks in then area

	Landmark & Location	Characterization & Background	Status	Potential Use
1	**The Grogan Castle** Build by Lord Grogan, a British Settler and Farmer in 1950's in Mata village of Jipe location	Historical landmark. Grogan and wife said to be buried in Castle. Famed for its conspicuous hill top location, "58 rooms, a dinning table larger than a tennis court"	Abandoned and vandalized. Now owned by a large-scale landowner and farmer who has also abandoned farm.	Museum, Cultural Centre, Tourist Camp/ Lodge, Tourist landmark
2	**Ngomeni** In Nogomeni Forest. Ngome means head. Used 50 years ago to burry heads of dead cut from corpses as a traditional rite.	Cultural and historical. Corpses were buried in a sitting position, beheaded few days later, ferried and buried in Ngomeni.	Not used for original purpose.	Cultural
3	**Keydong Hills Peak Shrine**	Cultural, historical	Used	Cultural. Traditional prayers and other rites

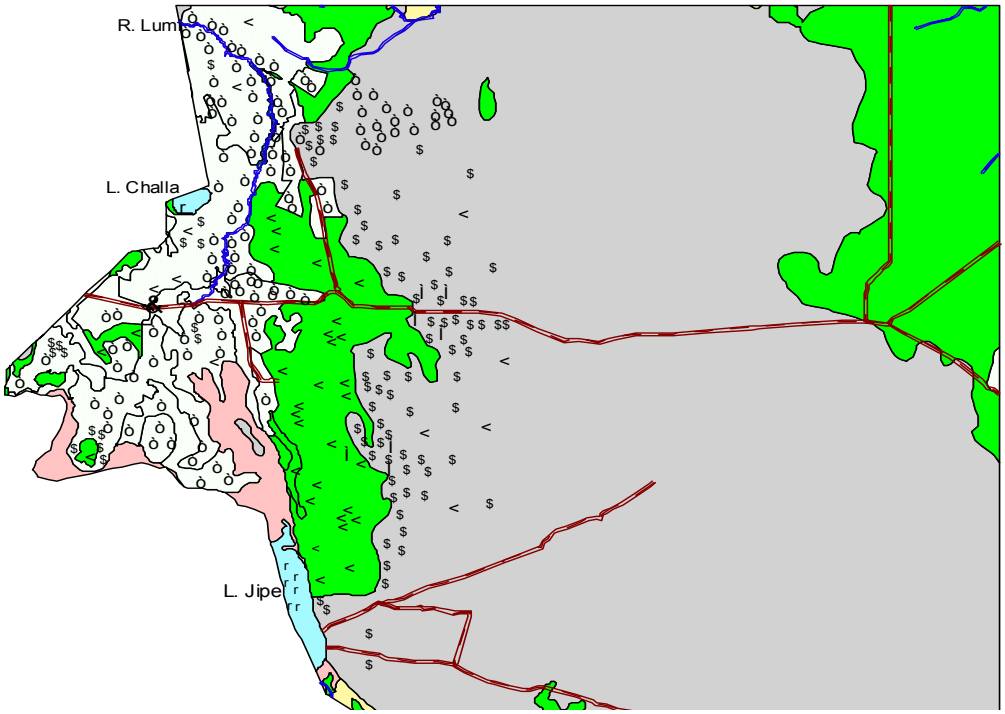
4	**Lake Jipe** Used as swearing shrine to settle disputes, prayers, sacrifices	Cultural, historical	Rarely used	Cultural, traditional prayers, offerings, etc
5	**Python Hill Shrine**	Cultural, historical	Rarely used	Traditional prayers, offerings, etc
6	**Lake Challa Shrine**	Cultural, historical	Rarely used	Traditional prayers, offerings, etc
7	**Baobab & Mukuyu Trees**	Prayers and sacrifices offered under these tree		
8	**Kishotang'oji Hill Shrine**	Prayers and sacrifices were also offered here.	Rarely used	Rehabilitated borehole and water well
9	**Commonwealth War Graves**	Where European and Indian people who died in WW1 are buried	Well kept and secured.	Tourist attraction
10	**The Boundary Beacon at Lake Jipe**	Historical, archeological.	Erected in the 19th century to mark international boundary on Lake Jipe	To mark boundary of Kenya and Tanzania within the lake
11	**The Lake Level Feet on Lake Jipe**	Historical, archeological		Used to measure water level in Lake Jipe

5.7.10 Political Issues

The locals claim that the administration was reluctant to support the commencement of the current project. The communities have proposed that development issues should employ a bottom up approach unlike the top down approach pre-dominant. This will be an incentive to the locals to actively participate in decision-making processes affecting development issues in Taveta.

Below is a map providing a representation of the key-socio-economic activities in Lake Jipe-Chala catchment.

ACTIVITIES MAP FOR L.JIPE-CHALLA CATCHMENT AREA.



r Fisheries.shp
¡ Sand harvesting (salaita and mata areas).shp
ò Intensive farming (irrigation schemes).shp
< High to slight tree felling and charcoal burning.shp
$ Intensive grazing areas.shp

Ke-urbanareas.shp
Taveta township
Ke-roads.shp
Ke-rivers.shp
Ke-waterbodies.shp
Lakes Jipe and Challa
Ke-forests.shp
Ke-agriculture.shp
Ke-rangeland.shp
Open to closed herbaceous vegetation
Shrub savannah or tree and shrub savannah
Sparse shrubs
Open to closed herbaceous vegetation on temporarily flooded
Closed to open herbaceous vegetation on permanently flooded land

N
W E
S

10 0 10 20 Miles

6 Key Stakeholders and Actors in the Lake Jipe Catchment

This section provides an analysis of the key stakeholders and main players that are associated with the prudent management and conservation of the Lake Jipe ecosystem. It includes the relevant government ministries, the communities, the local and international NGOs, and CBO's respectively.

6.1 Relevant Government Agencies

6.1.1 Local Authorities /County Council (Taita Taveta County Council)

The Council is responsible for urban planning, development, and provision of social services to town residences. The County Council has the following roles to play in the Lake Jipe Conservation Initiative.

- The Council should endeavor to increase the sewerage network to cover the entire county council area.
- Provide new channels for storm water drainage and maintain existing ones
- Provide refuse chambers and litter bins at strategic areas throughout the county council and empty them regularly
- Support private sector initiative in waste management e.g. privatisation of garbage collection, waste recycling etc
- Sensitize the public on waste management
- Undertake greening of the town
- Sensitize the council workers to enforce the public health and environmental health by- laws.
- Strengthen Pollution Release and Transfer Registers (PRTR) to ensure high standards of environmental safety within the County Council.
- Monitoring pollution levels at source.
- Ensure industries have waste treatment plants at the source
- Enhance education and awareness in planning of environmental issues
- Enforce environmental bylaws

6.1.2 Local Communities

The County Council has the following roles to play in the Lake Jipe Conservation Initiative.

- Participation in the activities of Lake Jipe Conservation Initiative
- Cooperate by showing compliance to existing environmental bylaws
- Market and mobilize support for the Lake Jipe Conservation Initiative among all the stakeholders
- Mobilize resources to support implementation of the Lake Jipe Conservation Initiative
- Provide networks and linkages between the implementation committee and the grass roots
- Mobilize community support and participation

6.1.3 Kenya Wildlife Service

KWS is responsible for conservation of biodiversity and natural resource especially within Tsavo West National Park. Its activities as relates to this Lake Jipe Conservation Initiative are:-

- Ensure ecological integrity of the park through proper planning and management
- Play a key role in supporting the implementation of the Lake Jipe Conservation Initiative and any other conservation initiatives of benefit to the Jipe ecosystem

- Support initiatives of the County Council and other stakeholders within the catchment
- Take a leading role in providing the technical capacity and scientific information to the proposed Lake Jipe Conservation Fourum
- Take initiative in collaboration with Forest Department, Agriculture and others to write joint proposals for funding to support activities already on the ground
- Establish strong network with other stakeholders
- Manage human wildlife conflict in the catchment
- Conduct research and monitoring in the catchment and in the Lake Ecosystem
- Promote tourism as an income generating activity in the catchment
- Undertake education, awareness and extension services to promote conservation

6.1.4 Forest Department

The Forest Department is responsible for conservation and development of forest resources.
In respect to Lake Jipe Conservation Initiative Forest Department is responsible for the following actions and activities.

- Rehabilitation and conservation of catchment forest
- Initiate and promote on farm forestry with the assistance of other stakeholders
- Work in concert with EAWLS, GTZ, IUCN, GoK, KWS and other agencies to address funding for catchment based activities
- Control of forest excision, fires and encroachment
- Interpret forest master plan and implement it in conjunction with stakeholders.
- Enforce existing laws to protect forests.
- Secure title deeds of the forest lands to protect forests
- Undertake education, awareness and extension services in the catchment
- Develop forest management plans.
- Provide a lead in forest research, monitoring and conservation.
- Coordinate the forest activities within the catchment
- Interprete the specific law relating to the activities of NGO's within the catchment dealing with forest conservation

6.1.5 Water Department

This government department is responsible for conservation and development of water resources. As regards Lake Jipe Conservation Initiative this department will be responsible for the following functions and actions.

- Protection of riverbanks in collaboration with stakeholders.
- Undertake education and awareness on water conservation
- Monitor and enforce water quality standards.
- Apportion water resources through permits and licenses for abstraction of water
- Spearhead water balance studies within the catchment.
- Gazette water sources such as springs in the catchment area, for effective protection
- Develop a code of conduct for water users in consultation with stakeholders.
- Interpret the water master plan.
- Maintain hydrological data.
- Act as custodians of information and database related to water conservation

6.1.6 District Environmental Committee

This committee is responsible for proper management of environment in the district. The functions and actions of this committee in the implementation of this plan will include: -

- Support the Lake Jipe Conservation Initiative implementation committee
- Recommend the gazettement of the Lake Jipe ecosystem
- Provide a link between the local committees and the national committees of NEMA.
- Mobilize resources to implement the plan
- Recommend to NEMA, the strategies of the plan.
- Give legal empowerment to the committee and the plan
- Provide linkages between government sectors and other stakeholders
- Act as an executive organ to ensure all development projects are environmental friendly
- Provide the link between the stakeholders and the public complaints committee

6.1.7 District Development Committee

- Ensure that environmental standards are adhered to in every development project.
- Co-opt stakeholders of the catchment.
- Seek recommendations of District Environmental Committee on development projects.
- Address poverty reduction issues
- Coordinate development programmes in the region

6.1.8 Local Provincial Administration

- Enforce environmental regulations on the ground
- Market and mobilize support for the Lake Jipe Conservation Initiative among the stakeholders
- Enhance information flow among stakeholders

6.1.9 National Museums of Kenya

- Maintain cultural heritage and monuments within the catchment area
- Conduct research and monitoring especially of water bird
- Disseminate research information to the committee and the general public

6.1.10 Non-Governmental Organizations (NGOs)

- Implementation of conservation and development activities in the catchment
- Collaborate with the committees in operationalising the Lake Jipe Conservation Initiative
- Encourage formation of Community Based Organizations
- Mobilise resources to support implementation of the Lake Jipe Conservation Initiative

6.1.11 Community Based Organizations (CBOs)

- Mobilize Resources and undertake education and awareness
- Provide networks and linkages between the implementation committee and the grass roots
- Mobilise community support and participation

6.1.12 Agriculture Department

- Coordinate agro-based activities to control soil erosion, pollution and siltation.

- Work in concert with stakeholders to ensure successful implementation of Lake Jipe Conservation Initiative.
- Provide relevant officers to be co-opted within the committee
- Lead in the development of a code of conduct for sustainable agriculture
- Integrate research findings into applied agriculture
- Promote good farming practices
- Identify good breeds and varieties of crops and livestock to increase production
- Identify plant species that are potentially harmful to the environment

6.1.13 Institutions of Higher Learning

- Collaborate with other stakeholders to develop proposals for funding
- Coordinate research activities in collaboration with stakeholders.
- Assist in monitoring of trends in the catchment.
- Provide technical support to the committee.
- Undertake Training as resource persons and enhance capacity building for specific stakeholders.
- Undertake technological development and technology transfer to stakeholders.

The table 14 below provides a compiled compendium of the different actors and institutions that are currently working on the conservation of the Lake Jipe catchment.

Table 14. Actors and stakeholders in Lake Jipe Catchment

	Groups / Institutions	**Activities**	**Progress So Far**
1	Local communities	➢ Restoration of Lake Jipe and R. Lumi ➢ Desiltaion of canals and ponds ➢ Clearing of river bank	➢ Marked improvement noticed ➢ About 3km cleared and desilted
2	EAWLS/GTZ	➢ Restoration of Lake Jipe and R. Lumi ➢ Desiltaion of canals and ponds ➢ Clearing of river bank ➢ Agroforestry development	➢ Marked improvement noticed ➢ About 3km cleared and desilted
3	EU – BCP/CDTF COSV	➢ Restoration of Lake Jipe and R. Lumi ➢ Desiltaion of canals and ponds ➢ Clearing of river bank ➢ Agroforestry development ➢ Extension of potable water line	➢ Activities on-going
4	KONAM	➢ Community mobilization ➢ Community health and environmental extension services	➢ Community mobilization ➢ Activities covers entire division
5	KWS	➢ Provides scientific information through research ➢ Managing human wildlife conflict ➢ Promoting tourism in the area ➢ Protecting breeding areas of the fishery ➢ Improving roads and general infrastructure of the area	➢ Baseline scientific information available ➢ Human wildlife conflict has reduced except for August to October each year ➢ Fish brooding stock available within the protected area.
6	IUCN	➢ On-going project on the conservation of Pangani river basin ➢ Mobilized resources for conservation activities in the area ➢ Communication, Education and Public awareness regionally ➢ Capacity building regionally	➢ Shared experiences on cross-border wetlands management ➢ Communication, Education and Public awareness regionally conducted ➢ Local capacity enhanced
7	Government Departments (Water, Fisheries, Forest, Agriculture,	➢ Enforcement of appropriate policies, legislation and regulations ➢ Community mobilization to support development initiatives	➢ Enforcement of appropriate policies, legislation and regulations has been dismal ➢ Community mobilization satisfactory

	Environment, Social services, Lands *etc*.)	➢ Provision of technical support services and materials	when facilitated ➢ Technical support services and materials available but not fully utilized
8	Transboundary Institutions and Regional bodies – EAC, AU, GoK and GoT	➢ Formulation and enactment of appropriate policies, legislation and regulations ➢ Providing enabling environments and financial support for joint transboundery research and studies. ➢ Establishment of relevant institutions	➢ Formulation and enactment of appropriate policies, legislation and regulations done ➢ Enabling environment and funding for joint transboundery research and studies inadequate e.g. ACTS and EAC. ➢ Establishment and co-ordination of transboundary institutions needs to be enhanced
9	Others: DANIDA, T-TAP, KWFT	➢ Borehole and shallow wells construction ➢ Alternative livelihoods	➢ 3km canal dug out, 3km remaining to the outlet

6.2 Environmental Trends and Threats to Lake Jipe and its catchment

This section illustrates the existing environmental threats and trends that are facing the Lake Jipe ecosystem and in effect contributing to its eventual decline. These facts have been derived from direct observation of existing phenomenon, as well as reliance on expert opinion and review of relevant literature.

The varied and valuable environmental resources of Lake Jipe ecosystem are subject to a series of threats with significant consequences for future development and conservation of the Lake. These include,

6.2.1 Siltation/Sediment Accumulation

Siltation is probably the most important problem in this wetland. Evidence of the same is seen along the Lumi River and along the banks of the Lake Jipe. Poor farming techniques upstream and along Lumi River have resulted in large amounts of silt being carried away and deposited either along the river or in the lake. According to residents in the region, the diversion of the natural course of river Lumi, bypassing Lake Jipe into Ruvu River actually happened during the El Nino rains in 1997. Deposited silt along the River resulting in a shallower river valley/channel and large amounts of storm water during this period seems to be the main cause for river diversion. See figure 9 below showing siltation problem in River Lumi.

Figure 9. Evidence of siltation along River Lumi

As a result, very little water reached the Jipe wetland while majority of the water in the River Lumi flowed directly into the Ruvu River, which flows down into Tanzania.

6.2.2 Typha Weed Infestation

Water reeds predominantly Typha and small pockets of Papyrus cover large areas in and around the lake as well as along rivers Lumi and Ruvu. The weeds have caused blockage of the water channels, constrained fishing activities and reduced the space and amount of water available in the wetland.

6.2.3 Water loss through Irrigation

Small-scale irrigation activities are carried out along the Lumi River with concentrations in Ziwani, Kimorigo and Miereni. There are two large-scale irrigation schemes, the Ziwani Farm and Basil Criticos' farm. The latter however has not begun irrigation activities as it had been left unattended for a long duration of time. Critical is the fact that there is intensive small-scale irrigation and water off take along the Lumi River that is not controlled.

There are no records to show the amount of water being abstracted from the River and hence no proper management to ensure sustainability. Rough estimates were made during the field survey based on the dimensions of the canal and speed of water.

6.2.4 River Course Diversion

The main cause of the diversions is attributed to the El Nino rains in 1997. The large volumes of water it is argued, forced open new channels and ended up flooding into the Ruvu River.

The abating factors to this scenario can be identified as the following.

1. Unstable banks due to cultivation in these areas
2. Siltation along the river hence raising the river-bed level and subsequently water level
3. Uncontrolled creation of canals majority of which even during the study didn't have gates for water control (particularly flood control)
4. Obstruction of water ways by Typha weeds along the river and in the lake
5. Natural topography of the area (flood plain)

Figure 10 below is a photo showing the illegal canals and diversions along River Ruvu.

Figure 10. Diversion canals

6.2.5 Overgrazing

Taveta can be divided into three zones in terms of livelihoods. There is the fishing community, farmers and pastoralists. The pastoralists (mainly Maasai) are generally found in the eastern zones of Salaita and around ziwani. Communities around the Lake other than the pastoralists also keep livestock. During the period the Lake was drying up, a number of the pastoralists moved towards the Lake in search of water and pasture (the typha weed and other grasses along the lake offered good pasture for livestock).

The reduction in the amount of water available in the Lake and River Lumi left behind sprouting Elephant and Kikuyu grasses as well as *Pennisetum mezianum*. These grasses provided a good grazing area close to the lake where the animals could access water as well.

Figure 11. Grazing along the edges of Lake Jipe

Figure 11 above is a photo showing areas where there are livestock that have eventually been greatly overgrazed leading to erosion by wind and water. As the lake forms a basin, all the carried silt is deposited along the River Ruvu or in the Lake.

6.2.6 Uncoordinated Canal and Flood Control Drains

There is a myriad of channels and canals in the irrigation zones and around Lake Jipe. Some are for irrigation purposes while the others are for flood control. These channels however seem to have been constructed haphazardly not exactly giving a clear indication of the flow of storm and irrigation waters. Figure 12 below further illustrates the existing channels constructed to control floods.

Figure 12. Irrigation canal

6.2.7 Invasive Species

The proposis species is rapidly invading and colonising large areas in Taveta. From observations made during this study, the area where the effect is acute is within the grazing areas as goats feeding on the pods of this plant act as the dispersal agents. Due to the colonisation by prosopis on land and typha weed in the lake, there is subsequent loss of biodiversity.

6.2.8 Charcoal Burning

Rampant charcoal burning has resulted in wanton destruction of trees leaving the ground bare and open to the agents of soil erosion. The figure 13 below shows a case example of on going felling of trees and charcoal burning activities as rampant in the area.

Figure 13. Tree felling and charcoal burning

6.2.9 Farming along River Banks

Farming activities especially in Kimorigo and Ziwani areas are carried out at the riverbanks. This has resulted in inundation of the banks and contributed to the already high levels of siltation and riverine degradation.

6.2.10 Lack of clear Land Tenure and Ownership System

Over 70% of Taveta district consists of two private farms. These are Ziwani and Taveta Sisal farm. The indigenous Taveta community are located along the Lumi River and around the various Njoro Springs. Pastoralist communities are significantly composed of the Maasai while the fishing community is predominantly Luo. Most of the local population of Taveta division live either on government trust land or as squatters in either of the two farms. Though title deeds have not been issued, the process is on track with land registration numbers already issued to those owning land.

6.3 Adverse Impacts of the Identified Environmental Threats

The mentioned existing threats and causes of the degradation of Lake Jipe and its catchment has resulted in the following adverse impacts that are being experienced by the communities at present. These adverse impacts include;

6.3.1 Increased human- wildlife conflicts

Lake Jipe, Lumi River and the Njoro Springs are the main sources of water for humans, livestock as well as wildlife from the nearby fringes of the Tsavo West National Game Park. During the period of low water levels in the Lake, wild animals moved into populated area in search of water and pasture.

At the same time illegal grazing in the park and overgrazing in the surrounding zones resulted in wildlife invading farms. Wildlife, particularly Elephants pose a great hindrance to agricultural production and a risk to human life.

6.3.2 Decline in Fishery

The fish industry forms a significant source of revenue for communities in the Lake Jipe area. Gradual degradation of this wetland however, saw the industry shrink up to about 50% of its original size by the year 2001. A number of reasons all of which are linked to the reduction in water amounts in the lake are attributed to this. These include:

- Reduced water levels and area covered by water hence a reduction in the habitat area.

- Increased salinity as a result of reduced water amounts affecting the viability of fish eggs.
- Over fishing
- Due to reduced water amounts and depth, fish were more susceptible to predation by primarily birds
- Destruction, drying and disturbance of the fish breeding areas
- Death as a result suffocation where water recedes and the periphery pools where some fish are dry up.
- Increase in temperature (during the day) due to shallower waters
- Most of the large fish – due to high temperatures – retreat to areas with reeds hence limiting large catch.

Table 15 and 16 below show the amount and trends of fish catch in Lake Jipe since 1993 until 2001 and the revenue derived during these periods.

Table 15. Fisheries Catch/Revenue

YEAR	AMOUNTS (KGS)	REVENUE (KSHS)
1993	103, 779	2.3 million
1995	141, 779	3.9 million
1997	88, 072	2.5 million
1999	88, 378	2.6 million
2001	64, 549	2.5 million
2003	71, 290	3.9 million

Source. Taveta Fisheries Department 2003

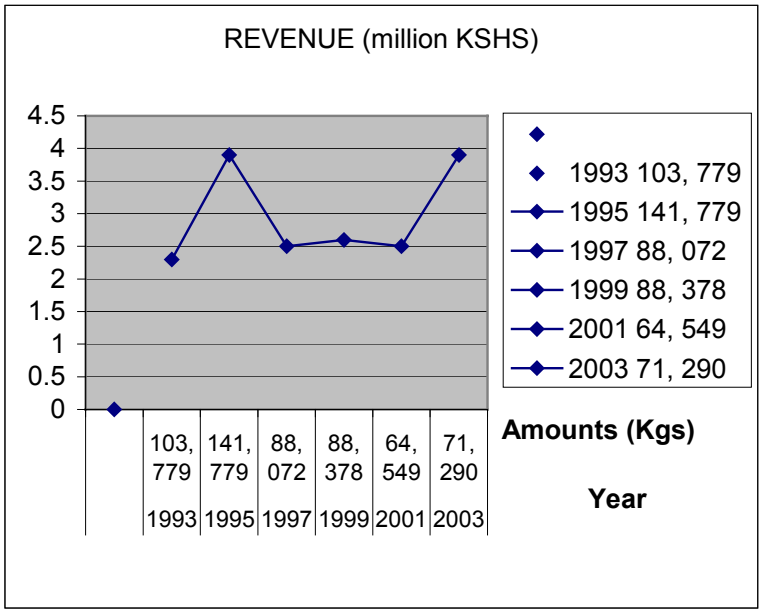


Figure 14. Trends in fish landing revenue
Source. Taveta Fisheries Department 2003

From the chart above it can be well noted that there was a sharp decline in the amounts of fish harvested in Lake Jipe through the years 1997 to 2001. There were no recordings on water levels so as to accurately evaluate the relationship between the water levels and fish amounts.

6.3.3 Increased stagnant waters

As water levels recede in the catchment, combined with course blockage from the weeds in the lake, pools of stagnant water are left behind providing suitable breeding sites for Mosquitoes, Salmonella and other disease causing organisms. Health status particularly of the communities living along the Lake was greatly affected with a significant increase of water borne diseases both in humans and livestock.

6.3.4 Lack of access to Fresh Water

Lake Jipe acts as a source of fresh water for domestic use for those communities living around it. In particular, communities in Kachero, Kilomita Saba and Mkwajuni depend on this wetland for fresh water. The communities prefer water from the middle areas of the Lake as it is deemed fresh and less polluted. The shrinking of the Lake has greatly undermined access to fresh water, as there is minimal flow of water. Communities from these areas have had to travel for approximately 10kms to Mata Village where there is piped water to access the resource.

6.3.5 Loss of Crops and Animals

The whole belt along the River Lumi and the Lake Jipe supports intensive small-scale irrigation activities. In addition, the two bodies together with the Njoro Springs provide water for human consumption, livestock and wildlife in the area. Diversion of the River Lumi and subsequent drying of Lake Jipe has affected crops and animals in two different ways namely:

1. Silting along the Lumi River resulted in flooding of farmlands between this River and River Ruvu. The result has been loss of cropsd and farmland to water. It is only until last year that farming in a majority of the farmlands took root again. A number of the farms are still to be reclaimed as the Typha weed has encroached in these areas.

2. Drying of Lake Jipe has resulted in reduced water amounts available for livestock and wildlife. The murky and muddy periphery of the drying up Lake has posed an additional danger to animals of getting stuck and/or drowning. According to community members, a significant number of animals were lost as a result of the drying up of the Lake.

6.3.6 Increased resultant poverty

Livelihood of the Jipe residents is highly reliant on the hydrological systems of the area. Activities are tied to the water resources available. Economic activities are mainly irrigation agriculture, fishing and livestock keeping all of which are dependent on River Lumi, Njoro Springs and Lake Jipe. Loss of agricultural and fishing resources as well as limited water resources for livestock greatly contributed to the rapid decline in productivity hence economic instability of the area.

6.3.7 Unsustainable alternative livelihood systems (charcoal burning, over fishing)

Due to the reduction of available resources to the affected communities, livelihood systems and sources shifted to bridge this gap. Most of these alternative sources of livelihood, if not all, were highly unsustainable either due to misuse, abuse or over use. Fishing activities further aggravated the situation through the harvesting of undersize, immature fish hence undermining the replenishment of this resource. This was as a result of limited supply against a high demand.

Farming activities were spread to ecologically sensitive areas such as around the springs and along the River Lumi where the banks had not broken causing flooding. As a result, erosion increased unabated and the problem of siltation in the Lumi River continued. The effect of this was that the very

problems that had caused the diversion of River Lumi and drying up of Lake Jipe were now on the increase due to their resultant situation.

Due to the problems facing the livestock and farming industries, charcoal burning significantly increased. Charcoal is sold both locally and in other nearby towns such as Wundanyi and Voi. The full effect of charcoal burning is yet to be felt as the Jipe area is a transition ecosystem between Ecological Zones III and IV. Charcoal burning's high contribution to deforestation in the area is bound to greatly influence ecological changes in the area.

6.3.8 Transmission of Sexual Disease

The sudden and downward shifts in income generation for communities around the lake and in particular the fishermen (whose majority coincidentally are squatters) encouraged a rapid encroachment of sex for money/food culture as a means of survival. This culture has contributed to the spread of venereal diseases and HIV/AIDS in the area. The Public Health Officer notes that probably the full effect of this spread has yet to be felt due to the disease's long and varying incubation period.

7 EXPECTED BENEFITS OF BCP/CDTF PROPOSED INTERVENTIONS

The support and intervention for the restoration of the Lake Jipe catchment is being funded by the European Union BCP/CDTF programme. Successful implementation of this program, which is being overseen by a Project Implementation Committee (PIC) comprising of several players in the area, is expected to overall lead to the following benefits.

7.1 Creation of Tourism and Eco-tourism opportunities

The restoration of the Lake will create an opportunity of reviving the Lake as a tourist destination zone. Wildlife has started utilizing the lake as a drinking point and the breathtaking scenery can be a tourist attraction. The lodges situated in the vicinity of the Lake should grab the opportunity and effectively advertise the Lake as a tourist attraction area. Tour guides guiding tourists in Tsavo should include the Lake in their route.

7.1.1 Reduction of Soil Erosion

The project has reduced sheet erosion at the Kimorigo area in that water is channelled to Lake Jipe through river Lumi. Thus incidences of water erosion as a result of flooding have greatly been reduced. This was achieved when the banks of the river were raised hence containing water.

7.1.2 Control of the Typha Weed

Control of flooding by manually desilting the river Lumi and construction of banks that contain the River flow has helped to control silt from being carried to the Lake Jipe. The silt is loaded with dissolved chemicals and fertilizers washed off from farms upstream. This dissolved chemicals lead to the increase in the nutrient content of the lake that provides a conducive environment for the growth of the typha weed. This has reduced the rate of spread of the weed.

7.1.3 Overall Boost in the Economy

The increase in the level of the Lake has contributed to an improvement in the economy of Taveta and the country in general. In terms of revival of the fishing industry, expansion of agriculture and a possible income from tourism now that wildlife has started returning to the lake. Fishermen can now

generate income from fishing activities and this will support auxiliary businesses such as transporters, sellers and the hotels that sell the fish. Areas for farming have expanded and this translates to surplus food that is sold off. This has generated income that is used for other activities such as paying of school fees and buying household items and this promotes the shopkeepers and the industries that manufacture such household items. The hotels and lodges will start getting tourists and this will provide jobs to tour guides and hotel staff. In summary the Lake's revival will help support several industries in the region and the country in general.

7.1.4 Employment Creation

This will be created in the fishing, farming, and hotel industry, in the project itself, the tourism sector and in the retail industry. The Lake provides indirect and direct employment to the locals in the form of,

- Fishermen
- Farmers
- Tour guides
- Hoteliers
- Casuals working for the project and
- Various supporting industries. i.e. shops, transportation, retailing etc

7.1.5 Improvement of irrigated agriculture

The project has improved agriculture especially in the Kimorigo area. This is so because the project has enabled to ensure flood control of the area. The area was once flooded due to the River and canal blockage. However when this was unblocked and banks repaired land for farming was created. Controlled irrigation was made possible and this availed water to the crops throughout the year thereby increasing food security of the area.

Agriculture has also improved especially after the squatters who were occupying Basil Critico's land were evicted, they had nowhere to farm hence compounding food insecurity in the Kimorigo area. But all this changed when flooding was controlled and another area for farming was made available when land was reclaimed after flooded water was drained. However for all this to be beneficial, the flood control should be permanent lest the situation worsens. Presently the farmers in the Kimorigo area are grateful the flooding has been controlled but they fear a food shortage might occur since the water controls in place are weak.

7.1.6 Restoration of Fishing Industry

The rise in the water level of the Lake has enabled fishing activities to take place. The population of the fish is steadily increasing as evidenced by fishermen who are returning to settle at Kachero village to resume fishing. To allow for the regeneration of the fish to mature sizes, a ban on fishing was instituted by the Fisheries department. The ban discourages commercial fishing. The Lake is a shared resource between Kenya and Tanzania but it's managed by conflicting policies. An example is the ban, which only applies to the Kenyan fishermen. This has created a loophole, which is exploited by fishermen from both sides. Fishermen from Kenya fish and sell fish to their Tanzanian counterparts. The fishermen from Tanzania use the small sized nets that catch small immature fish.

The revival of the industry has generated self-employment to the fishermen of the Lake. They are now able to feed their families hence a sense of food security. However the industry is facing some hurdles such as lack of facilities i.e. cold storage, quality fishnets but the project has helped revive the once dead industry.

7.1.7 Stabilization of the Ecosystem

The Lake is slowly being stabilized back to its original status now that water volume is slowly increasing and the supported bio-diversity is regenerating. The Lake is an important water reservoir and is habitat to various organisms. The interaction that existed between the adjacent ecosystems with the lake ecosystem will now be restored.

The Lake will moderate the anthropogenic climate change by acting as a sink of pollution, following injection by solution, precipitation and runoff. The ability of the lake to accommodate any increase in the supply of carbon depends on a complex combination of physical, chemical, biological and geological processes. The physical process will include mechanisms of gaseous transfer through the water surface, chemical processes allow the mixed layer slowly to accommodate far more carbon dioxide than can be taken up by physical solution. Further potential for accommodating carbon dioxide comes from the incorporation of carbon into planktonic plants and the zooplankton that feed on them and subsequently sinks through the lake carrying carbon (i.e. calcium carbonate) down the Lake.

The Lake will also contribute to ameliorating the climate change that occurs as the result of the fossil fuel (carbon dioxide) that remains in atmosphere. It will do so by reducing the thermal pollution created by the effect of atmospheric carbon dioxide on long wave radiation. It's whereby long wave radiation is absorbed by carbon dioxide, thereby contributing to greenhouse effect that leads to global warming. This is possible by the fact that the lake through various chemical, biological and physical processes will absorb carbon in the carbon dioxide.

The Lake ecosystem will also stabilize because the aquatic animals, i.e. fish, Hippos, and Crocodiles will now have enough resources from the Lake hence they will not migrate up the river source in search of food and end up creating unfair competition for resources with other organisms. This destabilizes the mentioned River due to resources being over utilized resulting to irreversible environmental consequences, such as extinction of specialized organisms (Crocodiles and Hippos) that cannot exist in congested environments that is suddenly overcrowded by organisms that had migrated to and from the drying Lake.

7.1.8 Change of supported ecosystems

The water from River Lumi supported River Ruvu and the dam at Nyumba ya Mungu. Thus when the diversion to River Ruvu was redirected to Lake Jipe, the volume of water in River Ruvu and Nyumba ya Mungu dam reduced considerably. This destroyed the habitat for Hippos, Crocodiles and other aquatic organisms that depended on the river and the dam. It also resulted to the death of some of the aquatic organisms especially the stationary ones.

Figure 15. River Ruvu

Fishing activities in the river and the dam was almost ground to halt. The fishermen that depended on the dam were forced to migrate towards Lake Jipe. The various supporting industries in the Nyumba ya mungu dam were forced to close down. This affected the living standards of the people in the areas and this impacted negatively on the Tanzanian economy. Electricity generation from the dam is no longer possible. This has affected the supply of energy for industries that depended on the dam. This had the short-term effect of forcing these industries to look for other available energy sources and it could have lead to the change in the prices of the goods and services they produced. The locals who depended on the electricity for lighting and other household activities were forced to look for other cheaper sources of energy like charcoal. This could have lead to the rise in the market of charcoal thus contributing to deforestation in the Pare Mountains.

8 PUBLIC PARTICIPATION/INVOLVEMENT

The community played a major role in this study. This is because they were the key stakeholders of the project. The study team involved farmers, pastoralists, fishermen and the following GoK departments; Ministries of Health, Land and settlement, Environment and Natural Resources, Water, Agriculture and the Provincial Administration (District Officer, Chief among others to solicit information, opinions and recommendations.

The Ministry of Water and the Ministry of Environment and Natural Resources were involved in the project at an advisory level. The Ministry of Environment and Natural Resources advocated for protection and conservation of water catchment areas and riverbanks by planting fruit trees that would protect the soil and riverbanks and provide an alternative source of food and income to the community. The other ministries were not deeply involved but were invited to several meetings concerning the project at the district level. The Ministry of Agriculture had the opinion that there was room for improvement if they offered extension services to the farmers on sustainable farming methods.

Several issues emerged from the communities that required focus and attention on for the project to be sustainable. Some of the concerns that emerged during the process are as discussed below

8.1 Poor Farming Methods

The farming method employed in the region is unsustainable and would bear adverse consequences to the environment and in the long run it might endanger food security in the area. The farmers derive their water through irrigation. They use furrow and flooding irrigation, which is mostly confined to rice fields, bananas, vegetable and subsistence crops such as maize and pigeon peas. River bank cultivation contributes to riverbank erosion and subsequent siltation at the Lake Jipe. There is a danger of fertilizers and chemicals used in the rice fields finding their way to the Lake through run off. If this were to persist for a long period of time it might change the nutrient content of the Lake resulting in eutrophication. The Ministry of Agriculture was concerned that river bank cultivation was detrimental to the ecosystem and on-farm soil conservation measures were not put in place; thus, the need for extensive agricultural extension, training and capacity building of the farming community

8.2 Land Tenure Issues

The land tenure system in this area affects agriculture. Lack of land forced the farmers to reclaim the swampy region in the area of Kimorigo. The reclamation of this important underground water recharge and filtration point will have a long lasting impact in the water balance of the area with very adverse consequences to the environment. The issue of squatters also discourages development because people of the area are discouraged from undertaking any permanent developments for fear of eviction without notice.

Incidences of disease outbreaks in the area are low. The only recurrence case is that of flu and common cold around Kachero area in the dry season. There is also a recurrence of East Coast Fever (*Theileria parva parva*) at the project area. This could be attributed to the fact that not all livestock owners spray or take their cattle to the dip. Thus the disease is spreading between the infected and uninfected livestock. Malaria outbreaks are also common especially around the lake area.

Wildlife is a liability to communities in the project area. Animals such as wild pigs, Hippos and Elephant have a tendency of destroying the farmers' crops especially when they are about to be harvested. Hippos and wild pigs disturb the farmers at the Kimorigo area who have farms near river

Lumi. A solution to the above problem would be to create a buffer zone between the riverbanks and the farmlands. Digging of trenches/moats along the river belt and around their farms would prevent Hippos and wild pigs from invading farms and destroying crops.

Wild animals have discouraged the farmers of Kachero from farming completely. This is because apart from their produce being destroyed they are constantly attacked while tending to their farms. A solution would be to have an electric fence to keep away the animals but an alternative source of energy need to be advocated for as presently they derive their wood fuel from the park. Another opportunity to solve this problem they said would be to invest in ecotourism projects with support from other entities such as NGOs and the Government so as to avert over-dependence on crops.

Some form of fishing is now possible at the lake. The size of fish caught ranges from 2.5-3 inches. The quantity caught after nine hours of fishing range from 500 – 800 in numbers. The size and quantity of fish caught is hoped to increase once the lake returns to its original level. The standard of living of the fishermen has slightly improved as they are assured of food security and for domestic uses is available. The Fishing community and fisheries department appreciated that the water level of Lake Jipe has risen and enabled some fishing activities to take place. However, they feel the fishing industry can be improved by harmonizing policies between Kenya and Tanzania, availing sophisticated cold storage facilities, boats, nets, patrolling the Lake to discourage illegal fishing, and providing market for fish.

There is a conflict of policies between the fisheries department of Tanzania and Kenya. This conflict gives leeway for farmers from the Tanzanian side to fish indiscriminately without taking into account the size of nets they are using. This also encourages the Kenyan fishermen to fish and sell their catch to the Tanzanians, as there is a fish ban in the Kenyan side. For the effective management of the resource it's important that the policies between the two countries are harmonized.

8.3 Farming

Farming is mainly concentrated in the various irrigation schemes strewn in the area. They include Kasokoni, Kimala, Kimundia, Kitobo, Majengo, Kamleza and Kimorigo. The farmers of Kimorigo represented the sample size for the study.

The farming village of Kimorigo was interviewed as it forms part of the farmers' population that is affected by the project area. A total of 15 farmers identified randomly from the area, formed part of the sample size. 80% of the farmers interviewed were previously occupying and farming on Basil Criticos' land before they were evicted after having farmed in the area for more than 10 years. 40% of the farmers had parcels of land both at the swamp area and at Mr. Criticos' land. Before El Nino most farmers had farms adjacent to River Lumi. They were forced to relocate in 1998 after the El Nino, as their farms got flooded when River Lumi burst its banks. They invaded Mr. Criticos' farm and were only until recently forced to move out due to lack of water and from being evicted. The farmers thus occupied and reclaimed the Lumi area, a swampy area.

The major types of crops grown in the area include;

- Maize
- Beans
- Rice
- Bananas
- Vegetables
- Tomatoes
- Oranges and

- Cotton

The farmers started planting rice in the area when they realized that the area was always filled with water and only rice could do well. Ninety percent of the people interviewed undertook farming both for consumption and market.

30% of the people interviewed did not use fertilizers as they claimed the soil was in good condition. The farmers that grew rice used a lot of fertilizers i.e. urea. It was applied at the rate of 50kgs for a farm of one acre. The other fertilizers employed included; booster for the rice crop, ridomil and glucopa. Herbicides in use include antracall and polytrin etc.

Soil erosion in the farming area is not that rampant. This could be as a result of the nature of the slope of the area that is a gentle slope almost flat. However there is soil erosion by water on farms bordering very close to the riverbank. This can be contained if the farmers are educated on the dangers of farming very close to the river. Digging trenches and filing them with mud to prevent soil sinking can also mitigate soil erosion

Of the farmers interviewed 50% did not use Acaricides and instead called the veterinary while the rest used acaricides. All the farmers interviewed have called the veterinary one time or another when their cattle became too sick. One of them had been trained on how to give the cattle medicine i.e. adamycn 5%. It came to the interviewer's attention of the existence of a project called T-TAP. The project taught about three farmers on veterinary services with the aim of assisting farmers when veterinary services was not easily available. There used to be a communal cattle dip where all farmers were required to take their animals. The former ex-chief largely enforced this policy. When the use of the dip was compulsory, there were no incidences of disease spread.

The drying of the lake affected mainly the farmers down slope next to the swamp area. The farms in this region were flooded when the river was blocked and the floods spread to the whole of Kimorigo area to the point where the local school closed. This was attributed to the fact that the riverbanks on the Kimorigo side weren't as strong as the banks on the Jipe side. Thus when it rained heavily the banks on the Kimorigo side burst and the area was flooded. The excess water resulted to the drying up of their plants. The flooding of the area did not affect the farms at the uplands and hence the productivity in such areas wasn't disrupted.

Essentially, the project benefited the farmers downstream as space was created for farming when water was contained and flooding significantly minimised.

8.4 Fishing

The project enabled water to reach the lake and over time it has reached a level where fish have regenerated and some form of fishing is possible. However the size of fish is not yet the recommended size of 3 inches. The ban on large-scale fishing by the Fisheries Department was to allow the young fish to mature to the recommended size. A fine of Ksh. 20,000 and the confiscation of the contravener's fishing gear is an attempt at enforcing this policy. However enforcing the policy is problematic as the lake is a shared resource yet the policy is not equally enforced on the Tanzanian side.

The fishermen are able to catch quantities ranging from 500 to 800 on a good day. They normally fish between 5.00 am- 2.30 p.m. The project has enabled the fishermen increase their daily catch. This was not the case when the lake was drying up. The size and quantity of fish greatly improved. The major types of fish in the area include but not limited to; Tilapia (Oreochromis jipe), Clarius cambaris

(Barbel fish) - common in dry seasons just after the rains, Sardine (Rastrineobola cirgentea), Spine fish and (Ningu) are common in the rainy seasons. The size and quantities of fish will increase once the lake's level returns to its original level.

8.5 Wildlife

Presently the villagers don't benefit from wildlife. Infact it's a liability to the farmers, fishermen and pastoralists in the project area. The animals especially elephants, hippos and wild pigs eat their crops just before they are harvested. They also attack their livestock and on occasions humans. Hippos and wild pigs are a menace to the farmers of Kimorigo whose farms are quite close to the River Lumi. They constantly invade their farms at night. They destroy the riverbanks erected by the farmers to keep away water from flooding their farms. They also invade the crops that are almost ready to be harvested consuming everything. This has forced some of the farmers to change their lifestyle and are forced to spend time on their farms where they have constructed huts on top of trees and spend their night drumming away in an attempt to scare away the hippos and wild pigs. The earlier flooding of Kimorigo area caused the hippos to migrate and came close to humans thus bringing about this situation. However, it is common knowledge that humans in an attempt to reclaim swampy land for farming have encroached onto the Hippo's habitats.

There are also dangers of being mauled by wild animals while tending to their farms. This has discouraged the farmers at Kachero village from farming for fear of being mauled. There is a potential of an increase in the population of wild animals in the area once the lake is fully restored and this will aggravate the problem of human-wildlife conflict.

The only solution to the current problem is fencing off the park with an electric fence or building dykes. But for this to be successful an alternative source of energy needs to be sought as the people of Kachero fetch their fuel wood from the park. Ignoring this problem would mean solving one problem while creating another. Thus to combat the issue effectively an alternative cheap source of energy needs to be established. Another solution to the problem would be to dig trenches deep enough to prevent animals from jumping or walking over to their farms.

An additional solution to the above problem would be to create a buffer zone between the riverbank and the farms in Kimorigo to a distance of around 30metres and to dig trenches around their farms that will prevent wildlife from crossing into their farms. Creating this buffer zone will be a problem because the land up to the river has been already issued with title deeds and already converted into farms.

8.6 Irrigation

All the farmers from Kimorigo interviewed get their water from irrigation. The irrigation method employed in their farms is furrow and flood irrigation and the farmers have come up with a timetable that they use to determine the period of time each farmer is allowed to irrigate his farm. This enables each farm to get adequate water to his farm. However this isn't true for all the farmers. The larger the size of the farm the longer the period allowed for irrigation. For example, a farm of 4 hectares is irrigated for 6 hours and the one of 12 hectares is irrigated for 12 hours. This method of irrigation has been used since time immemorial. This refutes the notion that farmers have diverted all the water into their farms thereby chocking the lake. However some of the farmers fear irrigating their land because River Lumi downstream is threatening to burst its banks and if they open the inlets their farms might be flooded. 3 of the farmers interviewed did not employ the use of timetables.

Flood irrigation is widely used in rice fields. This is where water is allowed into the farms until the area is flooded. There is a danger of fertilizers and chemicals in use to run off from the farms into the irrigation canals that drain into the lake. This in the long run might lead to the lake's eutrophication and change in its chemical composition. The lake's eutrophication will provide a conducive environment for the flourishing of aquatic plants. When the plants die there are oxidized by bacteria to form inorganic material and in so doing dissolved oxygen is depleted. This creates unnecessary competition for dissolved oxygen with the aquatic organisms. In the long run it will interfere with the biodiversity of the lake.

8.7 Land Tenure System

All the fishermen interviewed were squatters. This might affect the fishing enterprise and environment in general in that they don't have any incentive of building permanent structures and in undertaking any soil conservation measures i.e. gabions. There is also a fear of being evicted at any time by Basil Criticos, the landowner. Apparently Mr. Criticos had promised to give them title deeds but to date this has not happened. This issue, if not looked upon soon might affect the realization of some of the projects goals such as improving the living standards of the villagers.

The land ownership for all the farmers interviewed was freehold. This they acquired through reclamation of the swampy land and being issued title deeds by the Ministry of Land. All of the farmers in the region were once occupying Mr. Criticos' land as squatters before they were evicted and water dried in the Njoro canal. This forced them to occupy the swampy area and drained it to create space for farming. The issue of land may affect the implementation of some of the project goals such as alleviating poverty and improving local communities food security. For siltation to be effectively combated the banks of Rivers Lumi and Ruvu need to be excavated and proper afforestation and soil conservation measures undertaken comprehensively. However, this will create another problem of limited land hence food shortage.

The present land tenure system in the area affects agriculture in the future as the wetlands and swamps being encroached are converted for farm use. This is perpetuated by the issuance of title deeds by the ministry of lands on land that has been reclaimed. This will have along lasting impact in that wetlands and swampy areas that are important resources as they purify water flowing through the swamp. They assist in settling of sediments that would otherwise contribute to the siltation and blocking of rivers. They also act as underground water recharge points. Thus if they are interfered with the underground water regime will be affected which will in turn have far reaching consequences to water availability in the area. The biodiversity present in the swampy area will be invariably affected once human interference comes into play.

The people in the area of Njoro are pastoralists and squatters. This affects there development in that they don't have security in form of land on which to borrow loans that can assist them develop themselves. Investing on agriculture, pastoralism and construction of permanent buildings is a risk, due to fear of being evicted any time.

Those interviewed believe land tenure might affect the project negatively especially the squatters. With no incentives and insecurity there will be reluctance to implement any conservation measure being advocated.

8.8 Diseases

Before and after the project implementation, incidences of diseases have been at an all time low. Every fisherman interviewed had a mosquito net. Hence incidences of malaria are much lower.

However there are some incidences of flu and common cold during the dry season. This could be attributed to the dusty winds that frequent the area due to lack of vegetation cover. There is a need of encouraging the villagers to plant cover crops around the lake and in the village that will hold the soil firmly and reduce incidences of dusty winds during the dry season. There has been a recurrence of east coast fever especially in the wet season. This is largely concentrated in the Njoro area. Tsetse flies are also a menace especially to the farmers of Kimorigo. They attribute this to the fact that not every livestock owner takes their cattle to a dip thus spreading of the fly when cattle graze in the same area.

9 PROJECT POTENTIAL ADVERSE IMPACTS

The 'Emergency Community-Based Recharge Interventions for the Restoration of Lake Jipe' project is expected to result in a number of potential adverse impacts spanning over time and space. Some of the impacts are expected within the immediate precincts of the lake while others will traverse the Lake ecosystem and beyond as well as further downstream along the Ruvu River. The impacts experienced from implementation of this project include increased water amounts in Lake Jipe, significant increase in aquatic species numbers, increased economic benefits from fishing and irrigation, availability of fresh water for domestic use downstream and secondary impacts such as improvement in health, education and tourism.

Environmental Impact Assessments, as a decision making tool, was undertaken to promote sound environmental developments that balance opposing concepts of development and conservation to ensure sustainability. This process necessitates an evaluation of alternatives, positive and negative impacts to ensure an informed decision is made in light of environmental considerations. The process seeks to mitigate negative impacts, enhance positive aspects of the project thus ensuring the overall benefit of the project outweighs the costs.

The matrix in figure 16 was used to highlight the scale of the environmental impacts anticipated in the project. The matrix is an abstract and subjective decision-making tool but it is useful in helping ascertain how the project activities will affect the specified environmental attributes.

The weightings of significance within the tables below range from 0-3 whereby 0 represents no significance; 1 represents low significance; 2 means there will be some significant effect; and 3 represents high environmental significance.

Twelve (12) environmental attributes were considered against the project activities. A total score of 0-12 on any row represent an activity with negligible significance. A score of 13-24 represent activities with significant impacts that will require some intervention to avoid adverse impacts. Aspects ranging from 25-36 have high significance and these would have detrimental effects on the environment if left unchecked.

The matrices below convey the effects of the project activities against significant environmental attributes.

Table 16. Project Impact Matrix

Lake Jipe Project	Environmental Attributes												
Weighting **0= Not significant** **1= Low significance** **2= Significant** **3= High significance** **Project Activities**	**Water Quality**	**Erosion**	**Soil Quality**	**Fisheries**	**Biodiversity**	**Aquatic Fauna**	**Birds**	**Aesthetics**	**Income Generation**	**Food Security**	**Health & Safety**	**Human Wildlife conflcit**	**Totals**
I. Pre-Construction Phase													
1. Site Survey	0	0	0	0	0	0	0	0	0	0	0	0	**0**
II. Construction Phase													
Manual desilting of Lumi River	3	0	0	3	3	0	0	3	3	1	0	0	**16**
Repair damaged dykes	3	0	0	2	2	2	0	0	3	1	0	0	**13**
Extension of piped water	3	0	0	0	0	0	0	0	0	1	1	0	**5**
Purchase equipment for desilting	3	2	1	0	3	3	3	3	1	0	0	0	**19**
Establishing tree nurseries	2	2	2	1	1	2	2	2	3	0	0	0	**17**
Purchase of fishing gears	0	0	0	2	0	0	0	0	2	0	0	0	**4**
III. Operational Phase													
Unobstructed Flow of river water	2	0	0	2	1	1	0	0	3	3	0	1	**6**
Restore the lake's water amounts	2	0	0	0	0	0	0	0	3	2	0	0	**7**
Re-establish fishing Activities	0	1	0	2	0	2	0	0	3	1	3	3	**15**
Aforestation	3	3	3	0	3	0	2	2	2	0	0	0	**18**
	0	0	0	0	0	0	0	0	0	0	0	0	**0**
IV. Totals	**8**	**4**	**1**	**1**	**13**	**10**	**9**	**15**	**22**	**9**	**12**	**7**	**111**

The horizontal sum totals represent the significance level of the project activities on the environment. Not much emphasis will be placed on activities with low or no significance scores that are less than 12. For the project this represents manual desilting of the natural Lumi River course over a distance of approximately 5 kilometers from Lake Jipe, repairing of damaged dykes along the natural river course, organizing a series of community based workshops to sensitise the stakeholders on the need to adopt best conservation practices particularly along River Lumi and around its key sources (natural springs), provision of clean and fresh water to Jipe location residents through the extension of piped water from Mata village to *Kilomita Saba* village, activating an institutional arrangement or framework that will pursue long term conservation interventions for Lake Jipe, purchasing of assorted equipment for desilting the blocked natural river course, establishment of tree nurseries and supporting fishing activities through purchase of canoes, fishing nets, and fishing capacity building.

There were no notable aspects with high environmental significance (above 25). The mitigation measures will focus on activities that recorded some significance i.e. clearing of vegetation, desilting of river course and repair of existing dykes. The vertical totals depict environmentally sensitive environments. With 12 activities on each column, each attribute can have a maximum score of 36. The maximum score would represent a very sensitive attribute that will require some intervention to curb adverse impacts.

The impacts anticipated from the project are further discussed in detail below.

9.1 Impacts on Lake Ecosystem

Intervention measures instituted by the project bear a number of impacts on the lake's ecosystem. Some of the impacts are immediate while others will be manifested after a period of time. Situational changes brought about by the various activities of the project have culminated in a number of impacts within the lake's ecosystem. Among such impacts is the significant increase in water mass, increased aquatic fauna quantities, stabilization of food chains and webs, protection and conservation of important wildlife species and maintenance of the lake's ecological integrity.

The various impacts expected on the Lake ecosystem though varying is to a large extent long-term in nature and majority of these are latent i.e. occurring some period after project implementation.

Expected impacts on the Lake Jipe Ecosystem are discussed below.

9.1.1 Increased lake water flow and quantity

Manual desilting and erection of control dykes along the River Lumi course will result in a better-defined access way for water into the lake. These activities will reduce incidences of change in River course hence ensuring that majority of the waters along the river channel reach the Lake.

Prior to implementation of the project, water diversion (mostly unintentional) was severe especially in the low flood plains of *Kimorigo*, *Kamleza* and *Marodo*. Weak riverbanks and loose soils in the farmed areas along the river coupled with a myriad of irrigation channels are to blame for the water diversion. High silt loads within the river channel had resulted in reduced water holding capacities. As a result more water ended up following irrigation canals and channels to the southeast and eventually emptying into River Ruvu along the Kenya-Tanzania border (See figure 16).

9.1.2 Stabilization of the Lake ecosystem

The Lake is slowly being stabilized back to its original status now that water volume is slowly increasing and the supported bio-diversity is regenerating. This positive impact will have a magnitude to be felt a cross the borders effects in both two countries of Kenya and Tanzania who use resources from the Lake.

The Lake being an important water reservoir and habitat to various organisms will ensure that interaction that existed between the adjacent ecosystems with the lake ecosystem will now be restored. The Lake will moderate the anthropogenic climate change by acting as a sink of pollution, following injection by solution, precipitation and runoff. The ability of the Lake to accommodate any increase in the supply of carbon depends on a complex combination of physical, chemical, biological and geological processes. The physical process will include mechanisms of gaseous transfer through the water surface; chemical processes allow the mixed layer slowly to accommodate far more carbon dioxide than can be taken up by physical solution. Further potential for accommodating carbon dioxide comes from the incorporation of carbon into planktonic plants and the zooplankton that feed on them and subsequently sinks through the lake carrying carbon (i.e. calcium carbonate) down the Lake.

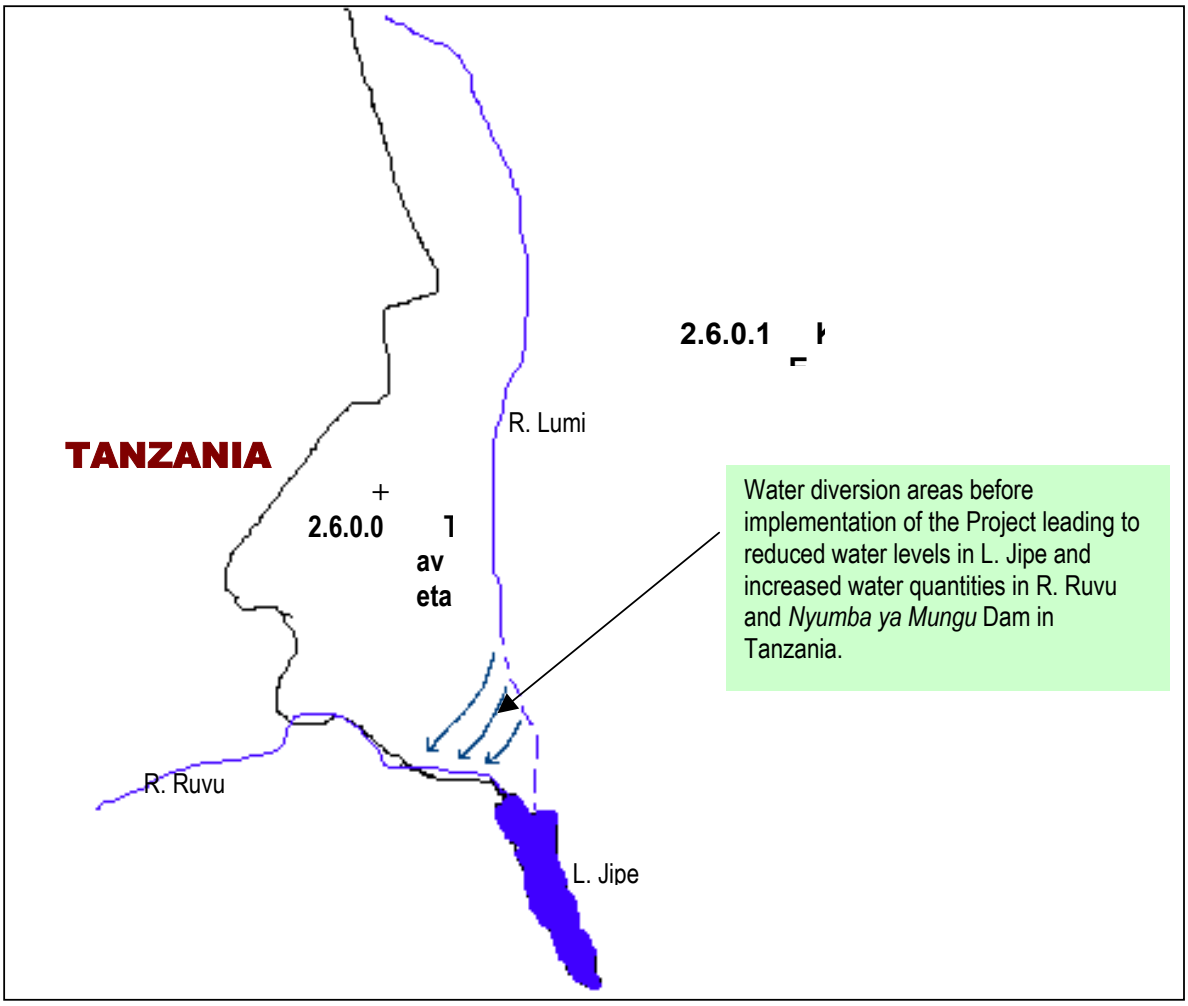


Figure 16. Water diversion map at the Lumi Delta
Source. ESF Consultants

The project undertook manual desiltation of the riverbed of River Lumi over a distance of 5km from Lake Jipe. In addition repair activities were undertaken on dilapidated dykes along the river's natural course. As a result, very little water was lost along the way. Within a period of five months, water levels in Lake Jipe had risen by approximately 2m.

9.1.3 Increase in Aquatic life

As a result of significant increases in water amounts after re-establishing River Lumi watercourse and subsequent increases in the lake's water level, there are signs of increase in aquatic life. This study used statistics on fish numbers and sizes as indicators to the increase in various flora and fauna species. During the period between project implementation and undertaking this study, no known water quantity measurements were done and therefore the only known quantities are those before the project and five months after. However, the fishing community around Lake Jipe recorded significant positive changes in fish numbers and sizes.

The increase in water quantities within the lake resulted in a number of factors that led to an upward trend of aquatic life populations. These factors include;

1. Increase in water surface area and volume hence an increase in the habitat size and capacity.
2. Reduced salinity levels providing more appropriate breeding and growth enhancing environs.
3. Reduced disturbance of nesting and breeding zones for aquatic fauna.
4. Increase in water depth hence reduced predation of fish by birds.
5. Increase in water oxygen level necessary for lower plankton growth. This in turn ensured an increase in available diet sources for various aquatic life forms such as fish.
6. Decline in fauna deaths as a result of suffocation and decimation of aquatic flora due to receding water mass.
7. Reduced water temperature fluctuations as a result of increased water quantity and depth. Sharp fluctuations tend to deny aquatic life optimal temperatures for existence.

9.1.4 Reduced Resource Over-exploitation

The downturn in Lake water recharge had resulted in a reduced availability of fish. Other than an increasingly competitive environment, overfishing became rife with increased fishing of immature fish. The project has ensured that lake recharge is back to normal state hence revamping water quantities. As a result fish growth and production has increased thereby reducing the incidence of over fishing and averting the subsequent threat of species extinction.

Through the years 1995 to 2003, fish production had reduced from a high of 141,779 kgs to 71,290 kgs signifying a drop of 49.72%. In essence, this was a drop by half the total production experienced in 1995. Due to this contraction in the fish resource base, communities living within the Lake Jipe ecosystem had to seek for other alternatives to their livelihoods. A small number of these communities ventured into subsistence farming due to a number of challenges namely;

- Limited availability of water for irrigation considering the harsh climate
- Limited capital to invest in other forms of economic activities
- Crop destruction by wildlife particularly elephants from the neighbouring Tsavo Park and hippos from the lake as well as Rivers Lumi and Ruvu.

As a result of these challenges, unsustainable resource use such as charcoal burning, sand harvesting and farming along riverbeds as well as overexploitation particularly of fish and forest resources were witnessed.

As water levels increased after implementation of the project, onsite direct observations and reports from the public as well as the Fisheries Department in Taveta indicated a steady increase in fish both in size and number. Fishing communities are returning back to fishing hence easing pressure previously exerted on the available resources within the region. No post-project quantified fish data was yet available during this study and therefore the report is not able to indicate quantitative increments in fish production.

9.1.5 Restoration of the Fishing Industry

The rise in the water level of the Lake has enabled fishing activities to take place. The population of the fish is steadily increasing as evidenced by fishermen who are returning to settle at Kachero village to resume fishing. To allow for the regeneration of the fish to mature sizes, a ban on fishing was instituted by the Fisheries Department. The ban discourages commercial fishing.

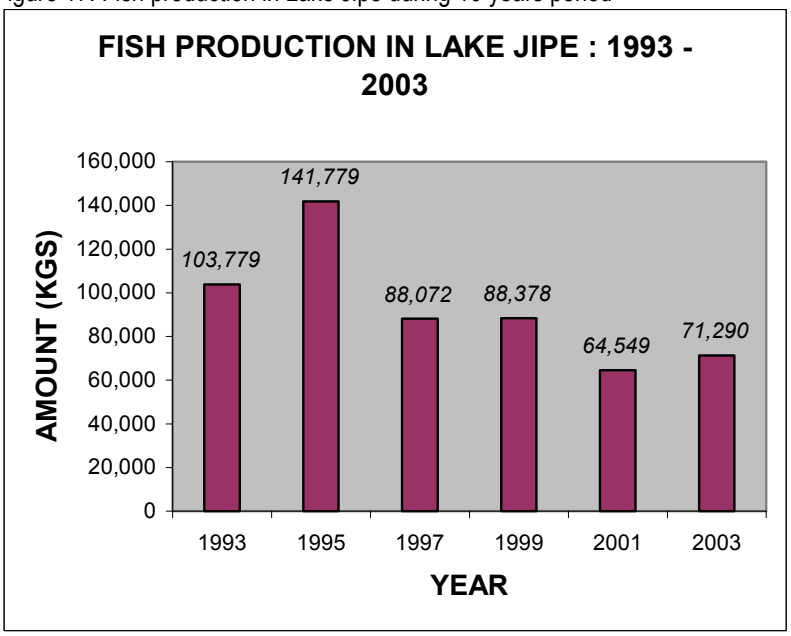
The Lake is a shared resource between Kenya and Tanzania but it is managed by conflicting policies. An example is the ban, which only applies to the Kenyan fishermen. This has created a loophole, which is exploited by fishermen from both sides. Fishermen from Kenya fish and sell fish to their

Tanzanian counterparts. The fishermen from Tanzania use the small sized nets that catch small immature fish.

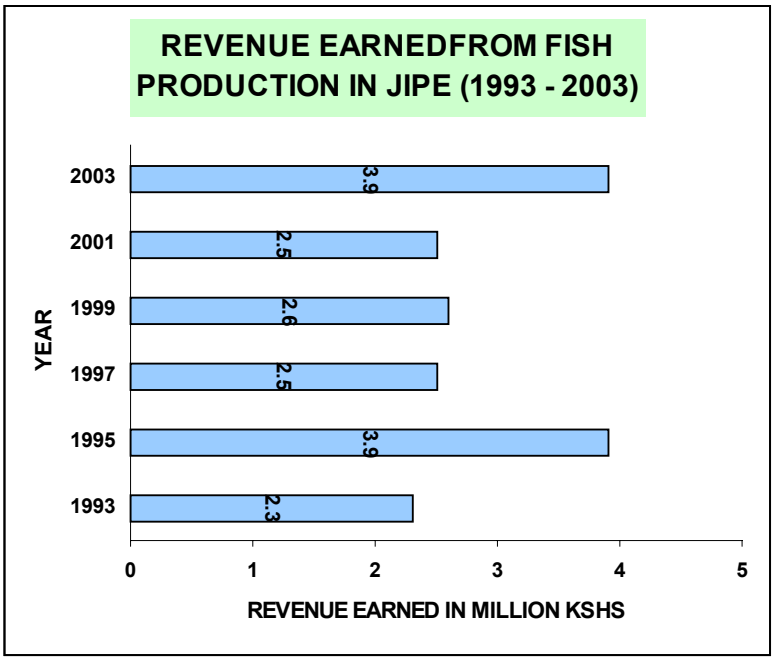
The revival of the industry will generate self-employment to the fishermen of the Lake. Fisherfolk communities are now able to feed their families hence a sense of food security is prevailing. However the industry is facing some hurdles such as lack of facilities i.e. cold storage, quality fishnets among others.

Lake Jipe was and still is a significant source of livelihood for communities living around it both in Tanzania and Kenya more so the fishing communities. Diminishing water amounts created stiff competition among the fishing communities and subsequent over exploitation and fishing of immature fish. Records of fish harvesting from the Fisheries Department in Taveta indicate a dramatic drop in fish production within Lake Jipe during the period of 1993 to 2003. The figure below (figure 17) illustrates the drop in fish production in Lake Jipe during this period.

Figure 17. Fish production in Lake Jipe during 10 years period



Source. Taveta District Fisheries Office



Source. Taveta District Fisheries Office

9.2 Impacts on Lake Jipe Catchment Areas

Lake Jipe has significantly two catchment areas, the Eastern slopes of Mt. Kilimanjaro (Rombo District) where R. Lumi originates and the Northern Pare Mountains in Mwanga District both in Tanzania. The catchment zone along the slopes of Mt. Kilimanjaro is defined by intensive small-scale agriculture, irrigation activities occur along the river belt (Lumi), which disappears around Kidonga Hill only to reappear after recharge from the Njoro Springs. Irrigation and some rain-fed agriculture proceed on along the belt and around the dam.

The North Pare Mountains rise from an altitude of 710 m.a.s.l to about 2113 m.a.s.l. A number of streams flow into the lake and R. Ruvu from these mountains. The lower slopes of these mountains are under crop though bush clearing for farming and tree felling for charcoal burning was occurring higher up the mountain range. This project in essence does not bear direct impact on the catchment zones of Lake Jipe but there are consequent and indirect impacts to these areas. These impacts include the following.

9.2.1 Abating Unsustainable Land use Practices

The dilapidated state of the Lake Jipe ecosystem had contributed to unsustainable and land degrading land use practices due o the loss of former livelihood sources. Loss of farmlands and shrinking of the lake's water mass resulted in local communities adopting practices such as charcoal burning, farming along river beds and overgrazing in the wetland riparian zones. The reclamation of Lake Jipe is already ensuring normal return to sustainable land use practices.

9.2.2 Population Influx

With the revamping of the socio-economic activities associated with restoration of the Lake including fishing, tourism and water, there set to be increase in population of people within the catchment. Majority of the people who had migrated from the area will come back to pick where they had left.

This increase in population to the area could lead to the situation reverting to its degraded status before the project intervention. Pressure on natural resources such as land for cultivation, water for irrigation, domestic use, energy, pasture and land for settlement will increase leading to further environmental degradation. Population increase due to restoration of the Lake ecosystem is a secondary latent impact that will occur after a period of uncertainty.

9.3 Impacts on Water Quality

Water quality in Lake Jipe had deteriorated significantly due to reduced water recharge and balance leading to stagnation and eutrophication contributed to by upstream use of fertilizers. Water quality tests undertaken in the early 90's on Lake Jipe, Lumi and Ruvu Rivers as well as the Njoro Springs indicated a high quality status. At this time Lake Jipe had fresh water but the high content of plankton observed within it limited its value (Kiema and Musyoki, 1996). Rapid change in water quality was experienced in line with the rapid deterioration of the Lake's state. Table 14 below illustrates this change.

Table 14. Water quality of Jipe in 2002

pH	7.6
EC	480
TDS (Mg/cl)	284.0
SO_4 (Mg/N)	<50
Nitrite (Mg/N)	<0.01
Nitrate (Mg/l)	3.0
NH_4NO_3 (mg/g)	0.4
Alkal (Mg/l)	323.0
Salinity (Mg/l)	65.0

Source: Taveta Divisional Water Office

Water quality assessment tests were undertaken in Lake Jipe. The tests were undertaken in two specific locations. Location 1 was in the middle of the Lake while location 2 was along the Lakeshores in Kachero Village. Table 17 below describes the results of the water analysis tests which is already showing a marked improvement in water quality as compared to the Table 16 above which show results of water samples taken in 2002.

Table 17. Water Quality in Lake Jipe 2005

Parameters	**Location 1**	**Location 2**
pH	7.3	7.8
Electric Conductivity	382	446
Total Dissolved Solids (TDS) – Mg/cl	193.5	91.7
SO_4 (Mg/N)	<50	<50
Nitrite (Mg/N)	<0.01	<0.01

Nitrate (Mg/l)	2.7	2.6
NH_4NO_3 (mg/g)	0.4	0.3
Alkalinity (Mg/l)	319	267
Salinity (Mg/l)	63.1	122.3

Source. Quest Laboratories

Figure 18 below is a further graphical comparison on water quality between 2002 and 2005 when the restoration of Lake Jipe commenced.

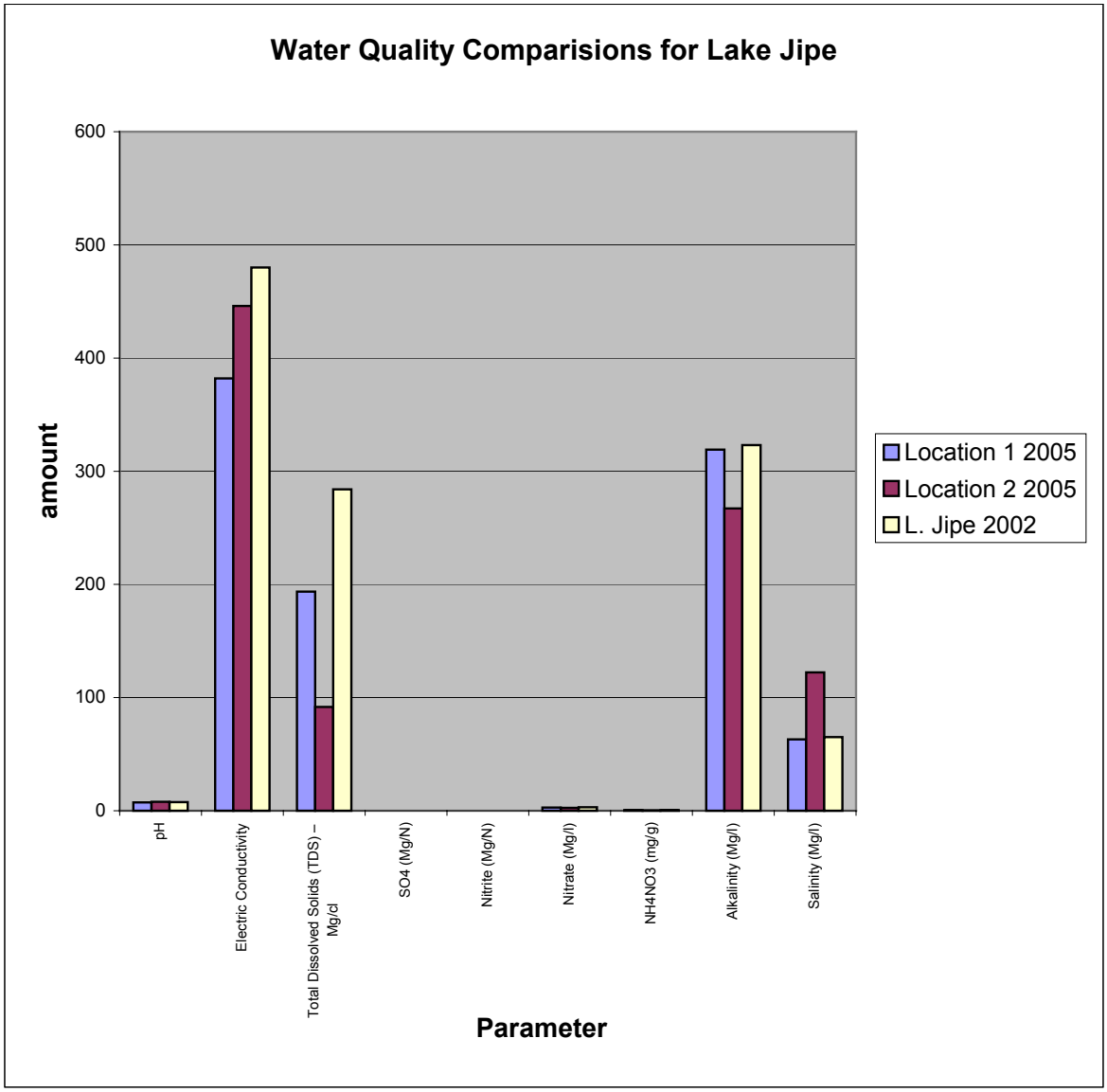


Figure 18. Water quality of Lake Jipe

Though the changes in water quality are not pronounced, they give a general indication of the trend water quality has taken since the rehabilitation exercise was implemented. It should be expected that

the return to normal water balance in the Lake will improve water quality and water oxygen availability.

Biochemical analysis done by the Taveta Division Water office indicated that water in the lake was still clean through the period of deterioration and did not have any coliform or E.coli and that it was of good microbiological quality (see appendix for test results certificates).

9.4 Impacts on Hydrology

The emergency recharge interventions of this project have elicited an impact on the hydrology of the Lake Jipe ecosystem and beyond. Changes in water velocities and route have resulted in a number of impacts. It should however be noted that majority of these impacts will take will take considerable time to properly manifest themselves. The impacts expected on hydrology will consist of the following.

- An immediate but periodic shortfall in water quantities downstream.
- More surface flow
- Less ground seepage and leaching

9.4.1 Reduced water amounts downstream

The restoration of Lake Jipe program was set about to restore the Lake's water amounts and ecological integrity. After the implementation of the project therefore there will be a deficit of water supply downstream in Ruvu River as because much of the waters will be retained in the Lake until it fills to initial status. This will be a short term cross border impact that will cease with the lake going back to its original status

Due to this, the downstream utilities along the Ruvu River will experience a temporary shortfall in the amount of water available therefore disrupting activities and sources of livelihood that depend on Ruvu water. At the time of undertaking this study the following effects could already be felt downstream:

1. Decline in fisheries leading to a reduced supply of protein and income
2. Unreliable supply of clean water
3. The function of Ruvu river as a medium of transport was impaired

Some of the utilities downstream that would be affected by the deficit include small-scale agricultural activities and the Nyumba ya Mungu Dam, which is used for hydro electricity generation and fishing.

9.4.2 Increased Surface Flow

Re-establishment of the River Lumi course has resulted in an increase in surface flow. This situation arises because water along the river course moves much faster than initially when it went through a swampy zone before arriving at Ruvu River. Due to this, there is reduced loss of water through percolation increasing the amount of water experienced in surface flow.

Increase in surface flow will initially not be felt in Ruvu River until towards arriving at the lake's full capacity when a water balance is arrived at. Increase in water speed will also reduce the standing time during which water within this ecosystem is exposed to evaporation. There will therefore be more water downstream as water loss opportunities are narrowed down at the project location.

9.4.3 Reduction in Ground Seepage

As a result of increased water speeds within a better-defined channel, there is reduced standing time which in effect ensures reduced percolation of water. Ground water recharge from this zone will

therefore be reduced. This impact however will not be very significant because the project area is within the low lying zones and the Lake Jipe flood plain does not stand as a vital ground water recharge zone.

9.5 Impacts on Biodiversity and Sustainability

Biodiversity within the Lake Jipe ecosystem is varied but is depicted by three distinct ecosystem types. These are aquatic, dry woodlands and scattered bushlands. Impacts on these ecosystems will be varied in nature, time and scale. Immediate and significant impacts will be felt within the aquatic ecosystem transcending to the other ecosystem. The impacts are discussed below

9.5.1 Introduction of new Tree Species

The establishment of community tree nurseries has the potential of introducing tree species new to the catchment. This could happen if the managers of the nurseries lack technical know how of identify appropriate species for the area. This scenario has occurred in Taita hills where exotic eucalyptus was introduced leading to loss of water and draining of wetlands.

9.5.2 Fauna including Endemic Species

Lake Jipe is a vital water source for a large number of wild animals and also provides a habitat for a variety of species such as the Hippos, Crocodiles and Water Monitors. The lake also has a variety of avifauna including many Palaearctic migrant waders and Inter-African migrant water birds, whose status on the lake is not clear. Restoration of Lake Jipe ensures sustenance of a vital ecosystem that supports a wide variety of biological life that was facing a threat from habitat destruction and deterioration.

9.6 Impacts on Downstream Livelihoods

The implementation of the project has had an effect on livelihoods downstream. Though ground investigations were not undertaken in the Tanzanian side, a number of impacts were identified from project resultant situations. As mentioned earlier in this chapter, the restoration of the original watercourse of River Lumi into Lake Jipe resulted in a subdued water flow in River Ruvu. This is because it required some time for Lake Jipe could fill up and normal outflow in River Ruvu restored.

9.7 Impacts on Upstream Livelihoods

Intervention activities implemented in the project are not expected to bear significant impact on upstream livelihoods (upstream referring to communities living on the upper reaches o the Lumi River). It is however anticipated that demand for water resources elicited by movement of people from the lake region to upstream zones will reduce as they move back to resume former livelihood activities.

Other spill over effects include reduced pressure on upstream woodland and forest resources as well as grasslands as restored capacities of Lake Jipe rejuvenate local economies offering income opportunities to local populations.

9.7.1 Reduction in Grazing Area

Filling up of the lake will result in flooding of drawdown zones, which were serving as grazing areas for the pastoralists during both wet and dry seasons. This reduction in real coverage of grazing land will have significant effects on the pastoral community livelihoods and indirectly affect the natural resources and more often increase in domestic wildlife conflict

9.7.2 Improvement of Agriculture particularly under irrigation

The project has improved agriculture especially in the Kimorigo area. This is so because the project has enabled flood control of the area. The area was once flooded due to the River and canal blockage but when this was unblocked and banks repaired land for farming was created. Controlled irrigation was made possible and this availed water to the crops throughout the year thereby increasing food security on the area.

Agriculture also improved after the squatters who were occupying Basil Criticos's land were evicted, they had nowhere to farm. But all this changed when flooding was controlled and another area for farming was made available when land was reclaimed after flooded water was drained. However for all this to be beneficial the flood control should be permanent lest the situation worsens.

9.8 Transboundary Resources and Resource-Use

Lake Jipe provides for a challenging situation as concerns transboundary resources and resource uses. As a transboundary resource itself, the lake is faced with a number of resource use problems particularly within the fishing industry. Differences in policy and legislation across the border present a problem for equity in benefit sharing and resource exploitation. Differences in policy and regulation has provided a challenging situation where Kenya had banned fishing while Tanzania allowed fishing to go on despite the threat such activity posed to the biodiversity of the ecosystem. Conflicts therefore arose as communities on the Kenyan side illegally relocated to the Tanzanian side so as to get an opportunity to fish increasing competition and rivalry.

In addition, the level of resource use monitoring and regulatory enforcement is bedeviled by uncoordinated efforts from both Governments. Restoration of the Lake regime will however temporarily offset some of the pressing issues experienced during its dilapidated state.

The sudden change in water quantities within River Ruvu due to the rehabilitation of Lake Jipe has asserted pressure on the downstream communities, which are basically in Tanzania. Reduced water amounts though temporary present a challenge for agricultural activities practising irrigation and more so on power generation in the Nyumba ya Mungu Dam. The Lake Jipe basin is an important source of water for Pangani River in Tanzania.

9.9 Impacts on Surface Water Sources

The restoration of Lake Jipe is not anticipated to bear any significant effects on the surface water sources of the area other than in irrigation. In the years of 1997 to 2004 some areas along the River Lumi Plains in Kimorigho and kamleza areas experienced flooding due to deviation of Lumi River. As the river course has been re-established, these areas will be once again open to agriculture and will rely on water from River Lumi for irrigation.

9.10 Impacts on Sub-Surface Water Sources

There are no foreseeable negative impacts on ground water sources. Most of the ground water sources are springs and boreholes upstream and the project will not affect water recharge significantly. On a positive note however, draining of areas flooded to river deviation and the creation/repair of flood control mechanisms i.e. dykes will ensure that there is reduced contamination of ground water sources in form of shallow wells that used by communities around

Extension of the water pipe from Mata Village to Kilomita Saba Village will increase demand on sub-surface water sources. Piped water in Taveta is obtained from the Njoro Kubwa Springs by the National Water and Pipeline Corporation. An increase in the demand base will increase demand

pressure on the resource. As this water is however for domestic use and livestock, the pressure exerted will not be very significant.

9.11 Inadequate Transboundary Resource Management

Proper and adequate Transboundary Resource Management is already an issue wanting in the Lake Jipe shared ecosystem. Though the project does not directly address the issue of transboundary resource management, it deals with issues that definitely require adequate and appropriate transboundary management and coordination such as water, fisheries and conservation initiatives.

It will be a futile affair to tackle problems relating to this ecosystem without putting into place a framework for cross-border collaboration and management o shared resources. Though there is little cross-border collaboration the project interventions will result in an increased demand for Transboundary Resource Management for the shared resources and in particular water and fisheries.

9.12 Biological Resources

The most significant impacts of the project interventions are to be felt in the biological regime due to the critical role that Lake Jipe ecosystem plays within the area as a permanent source of fresh water and green vegetation for wildlife, domestic animals and human populations.

There is an expected reduction of the area covered by bulrush and papyrus as well as the Typha species. This is due to the reduction of the area that was flooded prior to implementation of the project. Reduced predominance of the Typha weed will provide an opportunity for other present wetland flora such as planktons. Sustenance of the first tropic levels i.e. the planktons will transcend to higher biomass in the higher tropic levels.

There are around 50 species of submerged, emergent and floating plants in the lake and wetlands and an abundance of climbers that use the bulrushes and papyrus for support. All these species rely on the existence of the lake. These in turn are a source of diet for a wide number of species including fish, birds, hippos and other large fauna.

Similarly, the emergency restoration of Lake Jipe offer a lifeline of hope in the sustenance of the large variety of plants and animals relying on this ecosystem for habitat and nutrient requirements. Among these are larger wild fauna from the neighbouring Tsavo National Park in Kenya and Mkomazi Game Reserve in Tanzania.

Whereas River Lumi and Lake Jipe are important habitats for macro-invertebrates, no comprehensive studies have been conducted on invertebrates from this ecosystem. It is acknowledged however that this ecosystem has a rich diversity second only to Lake Naivasha (Nyangwara & M'Imanyara 2004). Conservational measures, awareness creation on conservational issues and rehabilitation of the lake ecosystem by this project will go a long way to ensure that vital biological life both known and unknown are not lost.

Expansion of the Lake back to its normal size and capacity will enhance growth opportunity and stocks for the locally existing flora and fauna hence adequately sustaining the complex food web and chains within this ecosystem.

9.12.1 Over Exploitation of Fisheries

Fishing in the lake will be boosted with the provision of fishing gear to the fishing community from the project kitty. Lack of control mechanism could lead in harvesting of under size fish thus jeopardizing fish stocks in the Lake. Control and monitoring is currently being carried out in an uncoordinated manner. The challenge of Lake Jipe being cross-border water mass is evident as fishing control lacks effectiveness. On the Kenyan side fishing net sizes are controlled while across in Tanzania this is not the case. Apparently, fishermen from the Kenyan side are crossing over to the Tanzanian side so as to fish without any controls. This has led to the harvesting of immature fish highly undermining the resource. There is need for a cross-border fishing control programme that is harmonised.

The Fisheries Department from both sides of the lake should establish a monitoring and control mechanism for abating destruction of fisheries in the lake through unsustainable fishing methods and sizes.

9.13 Impacts on Downstream Water Users and Uses

Downstream water users are predominantly small-scale irrigation farmers in Tanzania and hydropower generation in Nyumba ya Mungu Dam. Though the project will significantly result in reduced outflows in River Ruvu, the discharge should be able to resume to normal quantities within twelve to eighteen.

The situation will have an impact of irrigation limiting capacity and access but such will improve as water balances shift to normal over time. Deficits in water amounts flowing into Nyumba Ya Mungu Dam in Tanzania are also expected to limit the amount of hydropower generated. Pre-project amounts of water flowing out in River Ruvu were approximately the recharge quantities for Lake Jipe as most of this water was not going into the lake. Inflows from River Lumi into Lake Jipe are approximately at 7.5m^3/s whereas the outflows at River Ruvu are 5.5m^3/s.

9.14 Impacts on Upstream Water Users and Uses

The project interventions do not directly bear significant impacts on water users upstream. Minimal impacts may be felt with the ease of demand for domestic fresh water as communities around Lake Jipe resume accessing water directly from the lake and along River Lumi.

Water uses and accompanying uses upstream will largely go unaffected by the project interventions.

9.15 Impacts on Socio-Economics

This will be created in the fishing, farming, and hotel industry, in the project itself, the tourism sector and in the retail industry. The lake provides indirect and direct employment to the locals in the form of

- Fishermen
- Officials of fisheries department and the various government departments in the area
- Farmers
- Tour guides
- Hoteliers
- Casuals working for the project and
- Various supporting industries. I.e. shops, transportation, retailing etc

The fishing industry alone grosses approximately KShs.3 million a year, a majority of this being absorbed directly into the local economy.

Significant improvement in this wetland will ensure a positive improvement in direct and tangible benefits to communities living within it and beyond. This positive change will be felt in a number of avenues, which include:

1. Improved fish landing hence improved economic returns from the activity
2. Alleviation of flooding especially near the River Lumi delta. The area being very fertile due to high silt loads provides an ideal area for cultivation. This will lead to an increase in food supply and economic returns from the sale of foodstuffs especially to traders from out of the area such as Mombasa.
3. Populations have more time to concentrate on wealth creation as opposed to before where considerable time was spent on looking for water for domestic use.
4. Provision of appropriate fishing equipment will empower communities to improve on fish landing and avoid cases of time wastage or improper fishing due to poor and inappropriate equipment.

This secondary positive impact on socio-economic environment will alleviate poverty, which is part of the vicious cycle of environmental degradation. The impact will be immediate and both short term and long term. Without a good management plan this positive impact could result in negative effects on the both natural and social environment.

From data obtained from the Fisheries Department in Taveta and as illustrated in figure 19 and 20 below. Deterioration of the lake resulted in dwindling fish resources but revenue earned remained relatively stable. This means that it cost more to obtain unit fish and therefore this vital locally available resource was now not as easily accessible as before. The restoration of the lake ensures that fish stocks will improve not only improving the local and regional economies but also supporting protein requirements to poor communities living around Lake Jipe.

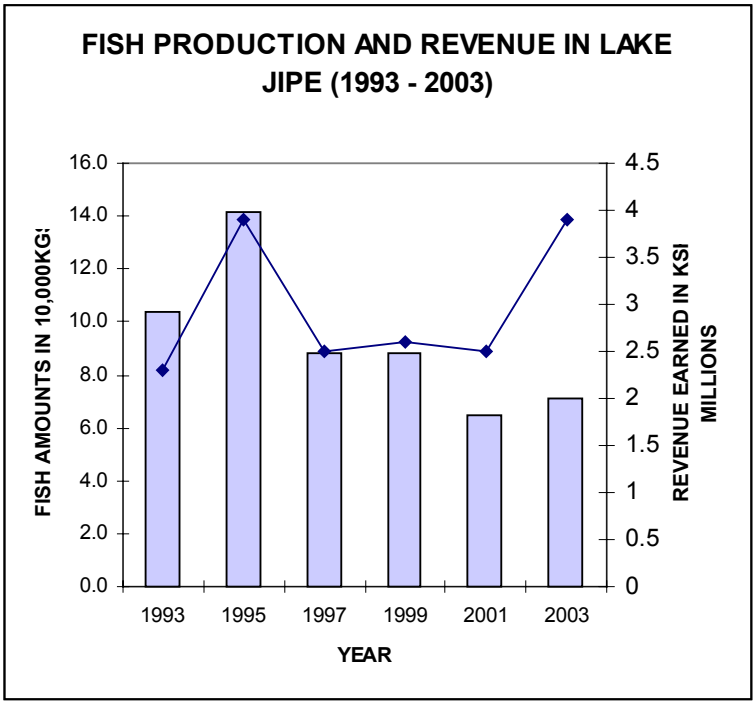
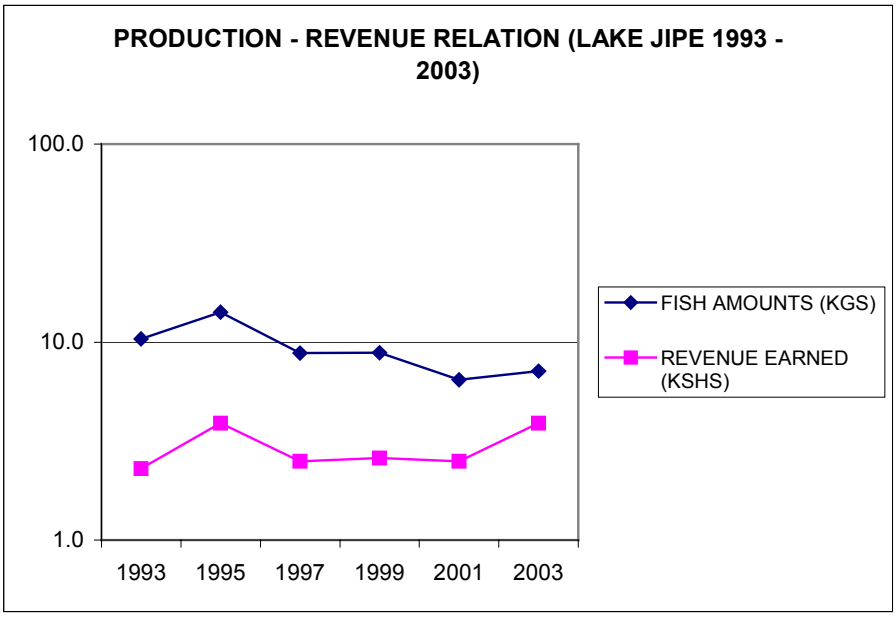


Figure 19. Fish production from Lake Jipe
Source. Fisheries Department in Taveta

Figure 20. Revenue from fisheries of Lake Jipe

Source. Fisheries Department in Taveta



9.16 Impacts on Hydrogeology

There are no significant impacts that are expected in this regime as the major change in water flow is on the surface and has very little possibility of affecting the underground qualities and quantities. The major recharge groundwater in the area is as a result of sub-surface conduits emanating from Mt. Kilimanjaro. There is therefore little difference in ground water dynamics as effects are predominantly to be felt on surface flow within Lake Jipe and River Ruvu.

9.17 Impacts on Land Tenure and Resource Use Rights

Taveta District has continuously been dodged by land tenure and user rights problems. This may be attributed to the skewed land ownership and high number of squatters. This project is anticipated to have minimal but very specific implications of land tenure in the area.

Implementation of an Environmental Management Plan (EMP) that also ensures enforcement of legal requirement for natural resource conservation and management will result in a number of land use changes particularly illegal/opportunistic farming along the river bank and illegal abstraction of water.

There will be a requirement that farmers and other community members alike provide for a riparian reserve along the rivers, springs and lake. A community based approach of the project has the potential of ensuring sustainable natural resource use and equity in benefit sharing through incorporation of a public participative approach and fostering environmental ethics and responsibility among the community.

9.18 Increased Livestock-Wildlife Conflict

Reduction in land for grazing will lead to livestock wildlife conflict. This reduction in pasture lands will translate to reduce pasture leading to spill over domestic animals venturing into wildlife areas in search of pasture leading to conflict

10 IMPACT MITIGATION MEASURES

This section describes the proposed mitigation measures of the potential adverse impacts of the proposed BCP/CDTF interventions and activities that are geared towards the restoration of the Lake Jipe cathment.

As revealed in the chapter before, some of the project interventions will bear negative environmental impacts. This section undertakes to discuss appropriate mitigation measures that should be incorporated into the project to ensure that such negative impacts are either totally eliminated or minimised to the best possible level. Mitigation measures have been discussed below in relation o the particular impacts that they seek to address.

10.1 Population Influx

As communities will generally be drawn to areas with economic potential and opportunity, it will be necessary to incorporate measures within this project so as to ensure that anthropogenic activities undertaken within the Lake Jipe ecosystem are of minimal negative effect.

To this effect, awareness creation and training on ethical and responsible wetland resource use is inevitable so as to ensure that the local communities are aware of the problems associated with improper use, over-exploitation and misuse of these resources and are well equipped to undertake sustainable natural resource use.

In addition it is imperative to develop a community integrated wetland management plan that incorporates the local community and that ensures commitment towards sustainable use and management of locally available resources. Different resource users should be identified and a management team created either as a committee or otherwise to oversee implementation of agreed code of conduct and addressing emerging issues and environmental threats.

10.2 Reduced Water amounts Downstream

The re-establishment of the original flow channel for River Lumi will result in an immediate shortfall of outflows at River Ruvu. Such shortfall could further be exacerbated by increased demands for irrigating water particularly in the areas that were previously unoccupied due to flooding. Reductions in water amounts will affect fishing, agriculture and hydropower generation downstream.

It is important to put in place effective monitoring programmes on water abstraction along River Lumi so as to ensure that downstream water users are not critically affected or activities impaired to high amounts of water use upstream. Such a program should be done in collaboration with the community, Ministry of Water, Ministry of Environment and large-scale irrigation estates.

10.3 Introduction of New Tree species

Before introduction of new species within the area during community forestry programmes, the project will need to incorporate research findings and advise from appropriate forestry bodies such as KEFRI and ICRAF so as to avoid cases where nuisance species are innocently introduced in new areas. Taveta and Taita areas have already experienced such an effect in *Prosopis juliflora* and Eucalyptus species respectively.

In addition, more emphasis should be placed on planting indigenous tree species and enhancing the community's capacity to develop indigenous tree nurseries for replanting in the area as well as for commercial purposes within and in other areas.

10.4 Transboundary Resources

Shared resources present serious challenges in ensuring sustainable use. In order to ensure sustainable management of Lake Jipe in is necessary to initiate a cross-border management plan that is all-inclusive and ensures harmonization of policies between Tanzania and Kenya. Such a management plan will ensure that activities within the lake are coordinated and do not conflict.

10.5 Overexploitation of Fisheries

Fishing in the lake will boosted with the provision of fishing gear to the fishing community from the project kitty. Lack of control could lead in harvesting of under size fish thus jeopardizing fish stocks in the Lake. Control and monitoring is currently being carried out in an uncoordinated manner. The challenge of Lake Jipe being cross-border water mass is evident as fishing control lacks effectiveness. On the Kenyan side fishing net sizes are controlled while across in Tanzania this is not the case. Apparently, fishermen from the Kenyan side are crossing over to the Tanzanian side so as to fish without any controls. This has led to fishing of immature fishing highly undermining the resource. There is need for a cross-border fishing control programme that is harmonised.

The Fisheries department should establish a monitoring and control mechanism for abating destruction of fisheries in the lake through unsustainable fishing methods and sizes.

10.6 Reduction in Grazing Area

Repair of the damaged dykes will control water from flooding the plains, which are used as grazing areas by the pastoralists during both wet and dry seasons. This reduction in area coverage of grazing land will have significant effects on the pastoral community livelihoods and indirectliy affect the natural resources and more often increase in domestic wildlife conflict

Encouraging zero grazing and destocking through developing livestock markets and improving breeds for increased productivity will help the pastoralist sustain the livelihoods within a much smaller land for pasture. Zoning of grazing area for livestock will help alleviate the problem livestock wildlife conflict when competing for grazing areas

10.7 Livestock Wildlife Conflict

Reduction in land for grazing will lead to livestock wildlife conflict. To curb this problem a buffer zone should be created to demarcate areas where livestock will graze to prevent spill over of domestic animals venturing into wildlife areas.

10.8 Socio-economics

Loss of crop and lives due to human-wildlife conflict as animal numbers increase with availability of water in Lake Jipe might increase. Livelihoods are bound to be affected where household heads and breadwinners are maimed or killed.

Enhancement of buffer zones through natural vegetation protection and creation ecotourism zones will assist in alleviating human and crop losses.

Population influxes in the L. Jipe zone will result in a number of spinoff effects. This would include insecurity problems, rapid spread of sexually transmitted diseases and increased deman and stress on limited available resources such as fuel wood, water and land. It is necessary for a comprehensive landuse and management plan to be instituted so as to ensure that resources are well utilized and over-exploitation. Community based land and environmental management committees will enhance a

participatory and effective approach to managing socio-economic and resource use issues that arise as a result of population increases.

11 PROJECT ALTERNATIVES

This section analyses the project alternatives in terms of;

- Alternative Technology and
- No-Project Option

11.1 Alternative Technology

The process of desilting the rivers, removal of the typha weeds, and construction of dykes will be undertaken manually without the use of mechanized equipments. Community members through food for work are expected to manually desilt and remove the typha weeds that have colonized the Lake Jipe. In the absence of using manual labour and implements for the above activities, the following alternative exists, namely;

11.1.1 Use of Mechanized equipments for desilting and removal of weeds

This is the application of tractors, dredgers and other mechanized equipments to undertake the above-mentioned activities. The use of mechanized implements for the above interventions is however predicted to have adverse impacts on the ecology of the resource base and could potentially lead to the degradation the natural resources present in the catchment. Therefore, the use of manual labor becomes a preferred alternative.

11.2 No Project Alternative-No Project Option

The overall goal of the proposed project is **"to recharge the rapidly drying Lake Jipe and improve the livelihoods of the adjacent communities"**, with the broad goal of enhancing the conservation of an important transboundary wetland ecosystem in Kenya and Tanzania. This is envisaged to be achieved by undertaking activities and interventions that are geared towards the achievement of the mentioned goal. However, The No Project Option in respect to the proposed project intervention implies that the status quo is maintained. This option is the most suitable alternative from an extreme environmental perspective as it ensures non-interference with the existing conditions. The No Project Option however is the least preferred from the socio-economic and even to a great extent conservation point of view due to the following factors that will be manifested in the following ways.

- Increased Siltation/Sediment Accumulation
- Accelerated proliferation of Typha Weed Infestation
- Continued Water loss through irrigation
- Wide spread River Course Diversion
- Increased Overgrazing
- Uncoordinated canal and flood control drains
- Increase of Invasive species
- Increased human- wildlife conflicts
- Continues Charcoal burning
- Uncontrolled Farming along the river banks
- Increased stagnant waters
- Decline of fishery
- Lack of Fresh water access
- Loss of Increased resultant poverty

The "no project" alternative envisages that no development activity will occur. Therefore all identifiable impacts will either be minimized or totally eliminated. However, the objectives of project will be forgone.

12 CONCLUSIONS AND RECOMMENDATIONS

In concusion, from this study it is becoming evident that indeed the restoration of Lake Jipe and the entire ecosystem has been long overdue and the support from the European Union BCP/CDTF Programme to restore the Lake is a timely intervention that is not only realising increased benefits in the conservation field but also is playing a major role in sustaining livelihoods and alleviating poverty. At this early stage of the project implementation, it is already evident that the project is surpassing the golas and objectives stated inspite of a few challenges that might be realised upon or during project completion.

Challenges that need to be addressed include the return of wildlife in the area as a result of the Lake Jipe rehabilitation is bringing up another issue of human wildlife conflict. This will have the effect of preventing farming activities especially in Kachero area. Maintenance of the irrigation canals to minimize unplanned and illegal water deviations presents another challenge. In addition proper catchment management will be necessary to avoid siltation along the canals and lake. Much of these challenges are brought about by community activities and will require strong monitoring and control measures.

12.1 Recommendations

The study team puts across the following recommendatiosn which it envisages will ensure that the sustainability of the project will be guaranteed. They include,

- The villagers occupying the project area need to be educated on the advantages and importance of conservation of their immediate environment.
- Alternative sources of energy need to be introduced in the project area. This will discourage the villagers from cutting trees for firewood and burning charcoal. Examples include the improved Jiko that utilize less charcoal. Trails with solar panels provide another viable alternative. The charcoal burners need to be advised on efficient methods of converting wood to charcoal that have a high rate of conversion.
- Tree planting should be promoted in the project area especially near riverbanks. This will discourage farming near the banks. Planting fruit trees will also have an additional nutritional and socio-economic advantage.
- Community conservation by laws should be encouraged. This will help in putting self internal and community regulated checks on utilization of the natural resources and thus promote sustainability.
- Farmers occupying the swampy area of Kimorigo need to be resettled in rain fed areas or a buffer zone of about 30 meters created from the riverbanks. This will help in reducing human-wildlife conflict and at the same time help conserve the banks from erosion and destruction. For the farmers in Kachero area and the adjacent villages, water pans should be constructed especially on the Tsavo side. This will discourage animals drinking from Lake Jipe from invading the farms.
- Farmers need to be educated on proper farming methods and capacity building, as the current practice will be destructive to the environment in the long run. Capacity building will sensitize them on the negative impacts of their activities. For example, they need to be educated that farming very close to the riverbanks will destroy the banks and eventually the river's silt content will increase resulting to river blockage.
- The Regulations between the Ministry of Agriculture and Lands need to be harmonized to avoid conflict. An example of a clash in rules is when the Ministry of Lands issues title deeds on land reclaimed from the swampy area of Kimorigo and yet under the Ministry of Agriculture such land is gazetted.
- There is need for construction/erection an electric fence in the project area that will permanently separate humans from wildlife. Also ditches/moats dug around their farms will prevent animals such as elephants and hippos from invading their farms.
- The desiltation of the canals should start from the Lake Jipe and not from the river source, as this will take into account all the sources of silt and materials that are causing blockage of the River Lumi and the various canals.
- KWS should improve their wildlife monitoring and compensation fee for injured parties should be reviewed, as the current amount is meagre.
- Title deeds need to be issued to the locals. This will go along way to improve their sense of security and they can improve their fishing and farming enterprises by acquiring loans from various financial institutions.
- The rehabilitation of the Lake Jipe should become a long term initiative instead of the current temporary solution. This is because there is a danger of the situation returning back to its original state if it rains heavily.
- The size of nets being employed by the fishermen at the lake should be of a standard size. This should apply both for the Kenyan and Tanzanian fishermen. This will curb the danger of fish populations dropping drastically in the future if not be given time to mature.

- There is a need of harmonizing rules existing between the two countries for the effective management of the lake. At the moment policies instituted at the Kenyan side are counteracted by policies existing at the Tanzanian side. This creates a loophole and conflict in the management of transboundary natural resources.
- A comprehensive Environmental Management Plan should be developed to include a land use plan. The EMP should have verifiable indicators and involve all the stakehiolders across the boundaries

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APPENDIX I

Terms of Reference

The study Terms of Reference (TOR) were,

Task 1. To identify and develop project area baseline data indicating anthropogenic activities, land uses, status of biophysical environment, cultural practices, socio-economic activities and actors. Description of the environment, assembling, evaluating and present data on the relevant characteristics of the study area. Information will include the following:

- Physical environment: geology, topography, and soils.
- Hydrological regime: surface drainage, lake water budget, groundwater dynamics, flood risk.
- Biological environment: forest/vegetation cover, existing wildlife (flora and fauna), rare or endangered species, wetland structure and function (including water quality and eutrophication, plankton, invertebrates and the food-chain), sensitive habitats, species of commercial importance, migratory path of birds, nuisance species, pests and vectors.
- Socio-cultural environment: land use and catchment degradation, resource use patterns, proposed developments, public health issues, demographics, livelihoods and sanitation management.

Task 2. Identify impacts of the project on the lake ecosystem and surrounding catchment area (including across the border): water quality and hydrological changes, biodiversity, and sustainability/ resilience.

Task 3. Identify and assess the impacts of the proposed intervention on downstream and upstream livelihoods, as well as trans-boundary resources and resource users.

Task 4. Identify and assess the impacts of the project intervention on:

- Surface water sources
- Subsurface water sources
- Trans-boundary resource management
- Biological resources
- Downstream water users and uses
- Upstream water users and uses
- Socioeconomic activities
- Hydrogeology
- Land tenure and resource use rights

Task 5. Identify and assess soil characteristics through soil sampling and tests along the riverbanks and lake to determine possible impacts of anthropogenic activities in these areas.

Task 6. Identify and explore the alternatives to the overall project or specific aspects of the project based on level of impact and sustainability potential (including the zero option- no action).

Task 7. Develop an Environmental Management Plan (EMP) for the project intervention. ***The study should address interventions to achieve long –term strategies***. The Management Plan to include,

- A land use plan
- Alternative intervention
- Project intervention design and technology
- Monitoring Plan

- Lake Jipe ecosystem management plan
- Impact mitigation measures
- Long-term sustainability concepts based on community active participation and ownership in the project.

List of People Met

Farmers

1. Justin Fundi
2. Josphat kamande
3. Mama houron
4. Leah Jumani
5. Eunice Lorogwa
6. Dorah Juma
7. Ernest Mkojozi
8. Alfred Mkapo
9. Dinaisi Mwanaidi
10. Roselynne Abembo
11. Kennedy Mongumi
12. John Pingili
13. Mark Juma
14. Michael Chokwe
15. Simon Fundi
16. Halima Mrutu—Tugurane Women Group

Pastorilists

1. Martin Lezan
2. Bwana Mkuu
3. Thomas Kalasinga Masenge
4. Paul Mkota
5. Joseph Mkota
6. Kenneth Erawi
7. Salim Husein
8. Salma Mapando
9. Alex Chonga
10. Juma Mkwaju
11. Peter Kalenge
12. Roslynne Alikwa
13. Kissinger Kiriga
14. Paul Kiringa
15. Gift Mpando

Fishermen

1. Kennedy Ngole
2. Rachel Mwagodi
3. Milka Bahati
4. Patricia Ouma
5. Laurence Hamisi
6. James Ojwang
7. Duncan
8. Emmanuel Mkubwa

9. Jackson Kelele
10. Lilian Pendo
11. Lydia
12. Paul Mkato
13. Albert Msenge
14. Alfred Tuju
15. John

District and Divisional Official interviewed

1. Ali Mwazei — District Environment Officer -Taita Taveta (NEMA)
2. Mr. Mungai — District Forest Officer
3. Ministry of Health
4. Ministry of Environment and natural resources
5. Ministry of Land and settlement
6. Ministry of Agriculture
7. Richard Donde — District Water Engineer -Ministry of water
8. Mr. Ali — District Agricultural Officer
9. Fisheries Department
10. District officer of Taveta