Environmental Impact Assessment Report
for
Tekeze Humera Irrigation Project

FDRE Ministry of Water, Irrigation and Electricity

Consultant: **Tigray Water Works Study Design & Supervision Enterprise**

Proponent: **Tigray National Regional State Bureau of Water Resources Development**

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Ethiopia

EXCUTIVE SUMMARY

I. Introduction and Background

The proposed Tekeze-Humera Irrigation Project (THIP) is located within the Tigray National Regional State, Western zone, in Kafta Humera woreda encompassing six rural kebeles, at a locality known as Heilegen. About 30,000 ha of low lying land would be irrigated from the reservoir behind and traditional small-holder mixed farming system based on rain fed and livestock husbandry would be transformed into a commercially-oriented agricultural system, based on re-organized small and large scale farms. The EIA study aims to evaluate potential social and environmental impacts and to develop mitigation mechanisms. It is conducted in accordance with the Ethiopian environmental policy and legal frame work as well as the African Development Bank Integrated Safeguard Systems.

The methodology involved site visits and discussions with the residents of the project area, meetings with affected stakeholders and questionnaires administered to households and key informants by following the standard EIA steps and methods. Typical activities carried under the study include, collection of baseline data on existing environmental settings of the project area, analyses of the project activities and their respective impacts on the environment, identification of the environmental components that would be most affected by the project, propose feasible measures that would help to avoid and/or minimize the adverse impacts.

Economic, social and environmental change is inherent to development and an EIA provides a unique opportunity to demonstrate ways in which the environment may be improved as part of the development process. Besides, the EIA provides for predicting environmental consequences of the development activities and plan appropriate measures to minimize the negative impacts and augment the positive effects. Though agriculture is the dominant sector of economy in the region, it is rain fed agriculture. It is well recognized that the western part of Tigray region specially that of Kafta Humera woreda is endowed with high irrigation potential. But due to lack of reliable studies regarding the potential resources and tangible implementation, it was not effectively utilized yet. About 30,000 ha of low-lying land would be irrigated from the reservoir of this project.

Objectives of the EIA Study: The primary objective of irrigation by itself is a social enhancement mechanism that enables the people to increase their food security. In this respect, it would be mandatory for such a project to be implemented in a manner that satisfies the requirements of environmental safeguard principles, policies and guidelines. The general objective of the EIA study is to conduct investigations that enable to assess environmental impacts of the development project (Tekeze-Humera Irrigation Scheme) and to recommend mitigation measures and highlight enhancement mechanisms by preparing possible environmental management and monitoring plans during planning, construction as well as operation phases of the project.

Methodology and Approach of the study: The EIA study is conducted in line with the EIA guidelines provided by FEPA. The approach of the study applied consisted of site visits, analyzing environmental issues that are identified from field observation of the irrigation site, literature review, conducting stakeholder and public consultations, focus group discussions and administering a series of questionnaire and checklists to identify likely impacts. During the site visits a detailed examination of the ecological

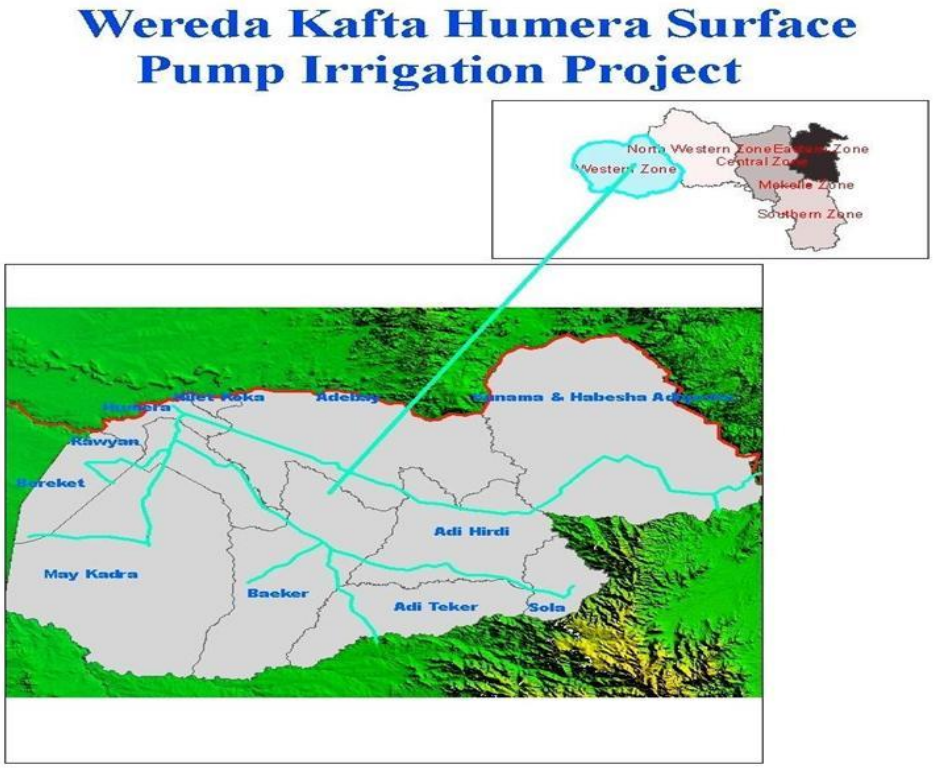
settings and measurement of several parameters of the area were done to set the baseline information. The environmental conditions existing in the proposed project area were documented to provide the baseline data. The likely changes in different environmental parameters were analyzed against the established baseline information and the impacts described in both quantitative and qualitative terms.

Scope of the Study: The EIA study of the irrigation scheme includes describing the baseline condition of bio-physical and socio-economic conditions of the project area, describing the proposed project and analyzing alternatives, identifying the major impacts of the project on the environment, proposing mitigation measures for adverse impacts and enhancement mechanisms for positive impacts, conducting public consultation process and finally preparing environmental management and monitoring plans.

II. Project Description

Throughout the Tigray region rainfall is marginal for agriculture production. In addition to the constraints of this rainfall, lack of modern agriculture practice suffered the region for a long period of time. To alleviate these problems and to achieve the food security of the region Tigray Water Resource Bureau has planned a development strategy that focus on utilizing the land and water resource efficiently using appropriate technologies. Among this Tekeze Humera Surface Pump Irrigation System is planned to irrigate 30,000ha from Tekeze River using pumping to higher elevation and use its gravity system. The development objective of this project is to increase irrigated area through investments that are cost effective, environmentally and socially sound, and beneficial to the rural poor with the purpose of sustainably increasing agricultural productivity.

Location and topography: The Tekeze Humera Surface Irrigation project is proposed on the north western low lands of Ethiopia. The project area is located in North Ethiopia, Tigray Regional State Western zone, in Kafta-Humera Woreda, on the left bank of Tekeze River. Kafta Humera Woreda borders with Tahtay Adyabo Woreda in the east, Wolkayit Woreda in the south, Eretria in the north and with Sudan to the waste. The approximate geographical coordinates of the project area lay between 36^0. 14‟ E, 36^0. 45‟ E and 14^0.06‟ N-14^0.20‟N with elevation between 600 and 750 masl. The project area border's with Humera town (the Woreda & Zone Administration Center) and Tekeze River to the north and extends up to 40km to the south. It is situated about 20 km from Humera town. The reservoir and pump station is located alongside the Shire-Humera main road towards northwest of Humera town at a locality known as Heilegen. Topographically, the project area is dominantly plain except some rugged terrain and shallow gorges in a few geologically unstable areas. Due to this the area is well endowed by both irrigable land and potential water modern farming development.



The irrigation system: The design study include Physical and hydraulic analyses and justifications for the sizing of system components such as Pound reservoirs, intake structures, irrigation infrastructures and main line. The design is structured into six pumping stations each having two main lines. Each main line is designed to transport 13,167.00 m^3/hr of discharge to irrigate 357ha of command area per one shift out of the 5000ha unit command. Each main line will cover seven shifts. Each of the main lines will transport water from the pump station structures situated at lower elevations to the pound reservoirs situated in slightly higher elevations. The irrigation water will then flow to the lower elevation farm fields by gravity. For example main line transports water from pump station one structure with elevation of 626.71 masl to pound reservoirs situated at 767.85 masl and from pound reservoir to the field at 736.42 masl. The material selected for these main line is GRP pipe because of the higher discharge and this type of pipe is popular worldwide and also used in the sugar industry in Ethiopia nowadays. In addition to this the friction factor is higher as compared to other materials. Therefore the pipe is sized DN 1800mm and PN 16 to sufficiently transport the water from the pump station one to the pound reservoir one with a velocity of 2 m/s with head of 115.42m. The total length of the pipe is 8475m.

Intake Structure: The intake structure is found up Stream of Tekeze-River to supply water for the first pump station. Intakes are provided whenever water is withdrawn from surface source such as lakes, canal, rivers, or reservoirs. There will be an approach channel through which the water will flow towards pump stations. At the entrance of the approach channel there are gates which are used during flood season to avoid entrance of flood in to the pump station as it will destruct the pumping plant. The water to be delivered to the pumping station must pass through trash rack which avoids entrance of sediment and debris.

Pump station and power house at the water source: The irrigation project includes electromechanical works of two pumping stations which will have the same property and objective. The pumps will also have similar pumping capacity. In order to pump the required amount of water from the river, there should be well designed pump with a properly coupled driver. The pumps shall fit with required discharge and head.

Canal design and structures: The Tekeze irrigation system design constitutes primary, secondary and tertiary canals that are necessary to convey the irrigation water from the pump stations to the farm fields. The canal routes goes through steep grounds, crosses a numbers of drains and footpaths, which needs different types of structures. The structures will include drainage culverts, reinforced concrete flumes (aqueducts), foot paths, road crossing, and cattle troughs**.** Whenever the natural ground profile is steeper than the design canal bed slope, drops have to be provided to avoid high filling.

III. National Policy, Legal and Institutional Frameworks

As part of the ESIA study a review of the policies, laws and institutional arrangements that govern environmental protection and the ESIA system in Ethiopia has been carried. The ESIA study also considered the African Development Bank Integrated Safeguard System and applicable Safeguard Policies. Among the policies, proclamations, regulations and guidelines issued by the government of Ethiopia and the ADB, the ones outlined below are relevant to the proposed project and were reviewed.

- ✓ Constitution of the FDRE
- ✓ Environmental Policy of Ethiopia (1997
- ✓ Water Resources Management Policy (2001
- ✓ Irrigation Policy
- ✓ Agricultural and Rural Development Policy and Strategy:
- ✓ Health Policy of Ethiopia: Environmental Impact Assessment (Proclamation No. 299/2002): Environmental Pollution Control (proclamation No. 300/2002):
- ✓ Public Health (Proclamation No. 200/2000):.
- ✓ Water Resource Utilization and Management (Proclamation No. 197/2000):.
- ✓ Environmental Guidelines:
- ✓ Institutional and Administrative Framework:

Reviewed applicable International Conventions to which Ethiopia is a party includes;

- ✓ Convention on Biological Diversity:
- ✓ Framework Convention on Climate Change
- ✓ Vienna Convention on the Protection of the Ozone Layer:
- ✓ United Nations Conventions to Combat Desertification:
- ✓ Stockholm Convention

- ✓ Convention on International Trade in Endangered Species of Fauna and Flora
- ✓ Basel Convention:
- ✓ The Ramsar Convention

Institutional and Administrative Framework: An important aspect of the ESIA process is the communication between different groups of participants. Because it reflects the various political and legal systems to show hierarchical structure and procedures for EIA preparation that result in the sound management and use of natural, human-made and cultural resources and the environment as a whole so as to meet the present generation without compromising the ability of future generations to meet their own needs.

Hierarchically, the Federal Environmental Protection Authority (FEPA) is the Competent Agency at the Federal level in Ethiopia (Now called Environment Forest Climate Change Commission). It is, therefore, the responsibility of this authority in the EIA process to: ensure that the proponent complies with requirements of the EIA process; maintain co-operation and consultation between the different sectoral agencies throughout the EIA process; maintain a close relationship with the proponent and to provide guidance on the process; and evaluate and take decisions on the documents that arise from the EIA process.

III. African Development Bank Integrated Safeguard Systems

The AfDB adopted the Integrated Safeguard System (ISS) as a tool for identifying risks, reducing development costs and improving project sustainability. The ISS promotes best practices in these areas but also encourages greater transparency and accountability and protects the most vulnerable communities. The bank has now adopted five Operating Safeguards (OSs) to achieve the goals and the optimal functioning of the Integrated Safeguards System (ISS). These OSs are:

- **Operation Safeguard 1**: Environmental and Social Assessment: this is an overarching safeguard of determining a projects environmental and social category and the resulting environmental and social assessment requirements.
- **Operational Safeguard 2:** Resettlement land acquisition, population displacement and compensation: this consolidates policy commitments and requirements contained in the Bank's policy on involuntary resettlement, and incorporates a number of refinements designed to improve the operational effectiveness of those requirements.
- **Operational Safeguard 3:** Biodiversity and ecosystem services: this seeks to conserve biological diversity and promote the sustainable use of natural resources with a focus on integrated water resources management in operational requirements.
- **Operational Safeguard 4:** Pollution prevention and control, hazardous materials and resource efficiency: this covers the range of key impacts of pollution, waste, and hazardous materials for which there are agreed international conventions, as well as comprehensive industry-specific and regional, including greenhouse gas accounting. The Bank's new screening tool for climate change risk helps in screening and categorising a project in terms of its vulnerability to the risks of climate change.

- **Operational Safeguard 5:** Labour conditions, health and safety: this relates to workers conditions, rights and protection from abuse or exploitation.

Operational Safeguards (OS) 1 on Environmental Assessment have been triggered because the project activities have the potential to generate significant environmental and social impacts to identified receptors within its area of influence. Operational Safeguard (OS2) has also been triggered because it could displace households and farmers from their settlements and farmlands. Operational Safeguard (OS 3) has not been triggered due to the fact that the Tekeze irrigation system main components do not involve construction of large scale structures like irrigation Dam near or inside the Kafta Humera National Park. There is excess cultivated land (155,000ha) outside the National Park and the 30,000ha command area needed for irrigation can be easily met without encroaching the National Park. Thus the Surface pump based irrigation system is less likely to significantly affect the biodiversity, natural or critical habitats. Operational Safeguard (OS 4) on Pollution Prevention and Hazardous Substances is triggered since construction and operation will involve use and disposal of different types of wastes. Operational Safeguard (OS 5) on Labour, Working Conditions, Occupational Health and Safety is applicable since the construction and operation phases will involve a significant number of construction and operation workers.

V. Environmental and Social Baseline Description

Climate and agro-ecology: Based on the data from various sources reviewed, 78% of the Woreda lies within the lowland, 18% mid highlands and 4% semi-desert agro climatic zones and the actual project site is within the kola agro ecological zone. The distribution of the rain fall in the area is not uniform. The rainfall pattern is mono-modal and more than 73% of the annual rainfall falls between June to September. The highest rainfall is in August (194.8 mm) and July (180.6 mm) followed by September (124.7 mm) and June (119.5 mm) and it is negligible in the rest of the months. The average rain fall within and the study area is 838.5. Mm/annum.

The temperature data indicates that mean monthly maximum and minimum temperature ranges from 32^0C to 42.4^0C and from 18.2^0C to 25.3^0C respectively. The average daily temperature is 29.8 ^{0}c. Maximum temperature reaches highest in April (42.4^0C) & Dec (41.1^0C) while the minimum temperature drops to the lowest in January (18.2^0C) which indicates its location within hot tropical climate zone. The relative humidity percentage is low to medium during the growing season, the maximum relative humidity is 71.8% in August while it was minimum in March (20.8%). The consumptive use of water by the plants is more when relative humidity is the minimum and vice-versa.

Geomorphology and Soils: Based on a survey and geological investigations majority of the project area comprises a homogenous feature that cover the ancient era processes. The drainage density and pattern are mainly controlled by the lithology, topography and geological structures and its pattern be described as dendritic type and flows from South-east to North-west direction. The site being far from the Ethiopian Rift, it is not susceptible to seismic hazard. Based on field survey and soil laboratory investigations the majority of the command area cover with a deep soil horizon which is greater than 150 cm. Soil texture is found to be clay, silt clay loam and sandy loam and soil is black in color with major soil types of Vertisols, Arnosols, Cambisols and Regosols. The command area is affected by erosion with varying

degrees and is not well terraced because of which erosion hazards is common, however the catchment is affected only by sheet and rill erosion which is not a significant constraint for crop production.

Hydrology and Drainage: Kafta Humera Woreda is highly endowed of surface water sources, owing at least 8 major rivers, namely Tekeze, Bahre-selam, Ruwassa, Gytse, Rawyan, Degagum, Mayamsalu, Zerbabit and Aykdubish rivers, of which the first five are perennial rivers and the rest seasonal.

Flora and fauna: The western lowlands of Tigray and its surrounding escarpments account for a largest natural vegetation cover. Kafta Sheraro National Park is among the vast areas with rich flora and fauna. However recently significant areas of the western zone has been degraded due to growing human pressure, wide spread deforestation and expansion of smallholder peasant cultivation, commercial farming and settlements. The vegetation in the proposed irrigation areas is predominantly woodland, which is characterized by trees with fairly large deciduous leaves mixed or interspersed with small leaved trees. The dominant tree species are of Acacia species such as Acacia etbaica, Acacia tortorilis, Acacia nilotica and Acacia seyal. In addition, there are strips or patches of riverine forest or trees along the rivers and streams that traverse the proposed irrigation area. Due to the intensity of human pressure, wildlife resources are limited to some areas in the south western zone and to a few remnant habitats like the Kafta-Sheraro National Park. The Park is neighboring the project area to the North West direction. According to the information obtained from the Kafta Humera Woreda Agricultural Office and local residents interviewed during the field survey, the wildlife species found in the project area consists of more than a dozen species (refer table 9, main report) including Leporidae, Sciuridae and Hystricidae and Orycteropodidae.

Land use and land cover: According to the woreda environmental protection, land administration and use and that of agriculture and rural development offices, the total area of Kafta Humera Woreda is 717,000 ha. The land use and cover of the woreda consists of 54.23% cultivated land, 33.47% forest land, 7.24% grazing area, 4.93% miscellaneous land use and the remain 0.21% settlement area. Though this shows the typical land use and land cover of the Kafta Humera woreda, every year there is tremendous land use change that tends to appear due to various economic and social phenomenons. Such event is reported to happen because of settlement expansion, massive infrastructure and development projects arrival, cultivated land demand, huge investment need, construction and energy demand. According to the detail study held in the project area the status of cultivated land is highly suitable for the expected surface irrigation project and there exists plenty of cultivated land with a net surface coverage of about 155,352 ha which is sufficient enough to feed the proposed project demand that is 30,000 ha.

Water quality measure: A field water quality measurement on Tekeze river surface water including at Heligen kebele site where the selected pump stations is located and in the nearby command areas was carried using EC meter. Accordingly, the EC value of Tekeze river water in the project area ranges between 0.341-0.395dS/cm and the TDS value between 186.24 - 204.8 ppm/l indicating a none salinity and proper ratio of dissolved total substances. The salinity ratio also ranges between 0.7-0.8% which is moderate and acceptable. The water quality samples taken from sub-surface and ground water sources around the command area contains relatively higher salinity and TDS value that ranges from 0.51 to 1.21 dS/cm and a TDS value of 223.5 to 425.3 ppm/cm. According to the FAO guideline, the water is suitable

for irrigation and will pose slight to moderate salinity which can be managed by selecting crops favoring this range salinity rate.

Environmental conservation: Environmental conservation is a recent phenomenon in the area even comparing with the other part of the Tigray region. Since 2008/09 rehabilitation activities massively started in major parts of the project Woreda including the specific project area. Data obtained shows that only small part of the total area is being covered by the environmental conservation activities and 4928 ha is made to rehabilitate physically and 2038 ha biologically making a total of 6966 ha. As summarized in the National Biodiversity Strategy and Action Plan of Ethiopia, the country has enormous habitat diversity due to its highly variable topography, wide range of elevations and climate.

Socio-economic profile of the study area: The project command area (PCA) is within Kafta Humera Woreda, which is moderately densely populated as compared to other zones of Tigray National Regional State (TNRS), and includes four kebeles completely and two kebeles partially with a total cultivated land of 155,352 out of which an estimated 30,000 ha will be irrigated. Official figures show that Kafta Humera Woreda has a total population of 115,580 with a split of 60,226 male and 55,354 within 29,324 households. Based on information obtained from the Woreda; there are a total of 62,150 residents in the project command area, out of which 54% are male and 46% are female. Moreover, there are 12,347 households of whom 3,158 are female headed households and 9,189 male headed households. The population data shows the average family size is 4.1 in the project area.

Data of the regional and local government documents indicated that majority of the population in the Woreda and that of the project area is mainly dependent on mixed agriculture comprising cropping and animal husbandry for their livelihood. High value crops like sesame and food crops like maize, sorghum and some supplementary fruits and vegetables like banana, tomato, potato and salad are typical income and food sources of this area while all types of livestock that contribute most to crop production activities and food sources of the community are reared in the project area. Irrigation is practiced within limited areas like river belts of the Tekeze river course while settlement pattern of the project area is characterized by well organized villages and semi township types.

Education and enrollment: According to the woreda education office there are about 42 elementary schools, 5 first cycle secondary schools (9-10th grade), one preparatory senior high school (11 -12th grade) and another one Technical and Vocational Junior College in Humera town. With regard to school enrollment, in 2014/15 academic year, there were about 30,637 students attending their education among which 50% were girl students. The average educational coverage of the woreda reaches above 90%.

Health facilities: Almost all the six kebelles in the project area have health service delivering facilities in side or their nearest district at 5-15 km far from their locality. Such health facilities include health post and health center within the specific project area kebelles. However, the health institutions are not well staffed and equipped with appropriate facilities. Therefore, when severe cases are encountered patients are referred to Humera and Shire hospitals. Tropical, waterborne and related diseases are affecting the living standard, life expectancy and working capacity of the community in the Woreda. According to

data obtained from Humera Hospital major health problems affecting the people in the area in 2014/15 were: Malaria confirmed with P.falciperum, Acute upper respiratory infections, Acute febril illness (AFI), Malaria other than falciparum, Diarrhea (non-bloody), Dyspepsia, and Pneumonia. The high prevalence of malaria is mainly associated with environmental and climatic factors such as altitude and availability of favorable vector breeding sites. The main transmission season is June to August, which may extend into September to December.

Leshmenyasis (Kalazar) is also a localized disease found in Humera and its surroundings. It is caused by tiny vector called sand fly dwelling in cracked vertisols. Tekeze and its tributary rivers is also the breeding site for snails which harbor bilharzias causing schistomasis. At least half a million temporary/seasonal workers are gathered every year in Humera woreda during sesame weeding and harvesting seasons. The laborers usually come from across the country with little or no awareness about vector born and STD diseases of the area.

Domestic Water supply and use status: In the project kebelles most water for domestic uses is obtained from groundwater. Groundwater is obtained from wells around some seasonal rivers like Rawiyan river and other ground water potential areas. Groundwater depths vary from 7m shallow wells around Rawiyan and Adebay kebelles to 150m deep wells in Mai Kadra and Bereket kebelles. As woreda data sources suggest that the coverage of the tap water supply in the woreda and that of the project area is estimated to be 86.2%. A total of 194 tap water sources exist in the woreda as a whole, out of which 41 are hand dug wells, 116 shallow wells, and 37 deep wells. Of these, functioning water points/ sources account for 18 hand dug wells, 81 shallow wells and 25 deep wells.

Energy sources: Three types of main energy sources are utilized in the Kafta Humera Woreda. The Woreda capital town, Humera, is connected to the national hydropower electricity grid since 2011/12. The coverage of electricity to the towns outside the Humera is progressively expanding. Fuel for cooking and heating is sourced mainly from biomass (fuel wood and dung) and electricity where available. In the rural kebelles alternative energy sources such as Solar power is widely utilized for lighting purposes. However, the energy source for majority of the population in the project area (more than 90%) remains to be primary wood biomass energy sourced from forest and animal dung.

Historic and Cultural Heritage sites: A rapid environmental assessment (REA) have been carried out in all interior part of the project command area and this screening result showed that no known preserved prehistoric, historic or officially recognized cultural heritage site existed.

VI. Public Consultation and Perception of the Project

Organized and structured public and stakeholder consultations has been held during the scoping phase of the EIA study in three representative kebelles (namely Central, Hilet koka and Rawiyan) by carrying interviews with residents, focus group discussions, formal consultative public and stakeholder meetings. Though the resident communities are generally supportive of the Tekeze irrigation project which they understand to lead to improved livelihood opportunities, they are overwhelmingly concerned about land

tenure and future use right among the project area settlers. Locally, farmers have three recognized land use rights viz. private, house hold and investment holdings.

Farmers are concerned that the project could result in either an absolute loss of land or loss of access to some plot of land due to the project infrastructure and re-distribution. Some of the important concerns raised by the participants during the different consultation phases include the following points: possible displacement to make way for commercial farms or "investors", having to change cropping patterns and systems especially their local cash crop sesame, the changing and re-shaping of the usual grazing pattern, the condition and fairness of future water fees, the size of future irrigable land, and price drops due to over-production and inadequate markets. At the end, most of the participants have eagerly welcomed the proposed irrigation project to their locality.

VII. Project Alternatives

The EIA study considered possible alternatives viz. no action alternative which has various negative and possibly long term impacts to the area, some of which include increased water losses and wastage in the existing irrigation schemes, loss in productivity of the land, increased socioeconomic activities detrimental to environment such as charcoal burning, increase deforestation, unemployment to support livelihood etc. Several irrigation systems including sprinkler irrigation, flood irrigation, drip and surface irrigation methods were studied and considered and the latter i.e. surface irrigation has been rather found to be convenient to the project area both interns of technical as well as economic feasibly and environment friendliness. Design and location alternatives have also been considered.

VIII: Environmental Impacts and Mitigation Measures

The environmental impact prediction and analysis has been focused on both construction and operation phases separately. Irrigation contributes to poverty alleviation, food security, and improving the quality of life for rural populations. However, the sustainability of irrigated agriculture is being questioned, both economically and environmentally. The increased dependence on irrigation has not been without its negative environmental effects. Positive impacts include enhanced agricultural productivity, boosting of employment both permanent and temporary, ensured food security and reduced poverty. Negative impacts during the construction phase can be short lived but may pose a great danger to the environment, if not well managed. These are increased clearing of vegetation leading to limited loss of biodiversity, temporary disturbance to wildlife of the nearby National park, loss of land and potential displacement of farmers. Increased soil erosion and siltation, increased traffic and soil compaction, pollution of rivers and wetlands etc are also among the anticipated negative impacts.

The contractor demands land for site offices, workshops, stores, vehicle parking, and staff accommodation, temporarily for aggregate processing and concrete manufacture, metal fabrication, back-up power generation, and access roads. The mitigation options include allocation of low value land, compensation for lost income, and reinstatement to its original condition, maximum use of land planned for permanent roads. The construction phase impacts which will require bulk mitigation measures are borrow pits and quarries which need to maximize the re-use of excavated materials as fill in the works as part of remediation. The construction process will involve the creation of various solid and liquid wastes

and the use of hazardous materials and its impact should be mitigated by effective waste management and pollution control mechanisms. The pump station construction will involve working in and near water which may temporarily degrade water quality and physically alter or block fish movement, and in order to mitigate these impacts undertake all works during the dry season and adapt fish friendly construction techniques. Land acquisition and consolidation will immediately disrupt household cropping practices and need to be compensated with replacement land and other relevant entitlements.

Post construction or operation phase impacts may arise from inadequate labor skills and field equipment and has to be managed by providing technical and logistical support. Soils in the command area are almost vertisols which expand when wet and become impermeable. This may occur as a reason for salinization of soil and water monitoring should be included in the full-scale trial. The project will alter vegetation communities in the command area and its vicinity and both habitat diversity and other ecological areas are likely to continue to decrease, thus should be managed to ensure that habitat diversity is retained, specifically by redrawing the project boundary to exclude development of some habitat area within the command as well as Kafta Sheraro National Park.

XI: Environmental Management and Monitoring Plan

This environmental impact report has identified a number of potential environmental and social impacts associated with the project and have developed mitigation measures. The environmental management plan aims at controlling adverse impacts at the source to the extent possible with the available and affordable technology followed by treatment measures before they are discharged.

Environmental management plan (EMP): The basic concern of EIA is to identify, predict and evaluate impacts of the project activities on the environment and to formulate mitigation strategies to minimize adverse impacts that are likely to occur during project implementation and operation. A management plan is the process of implementing mitigation measures in accordance with the schedule of actions contained in the EMP, together with any necessary adjustments to respond to unforeseen impacts or other changes. Accordingly the environmental management and monitoring plan of this irrigation project has been formulated using five point approach viz. impact avoidance, impact minimization, compensation, sustainability and enhancement of positive ones.

Environmental Monitoring: Monitoring allows the mitigation measures and conditions attached to project approval to be fine-tuned in the light of new information. The primary aim of monitoring is to provide information that will aid impact management and continually; to achieve a better understanding of cause effect relationship and to improve environmental assessment prediction and mitigation methods. When used systematically, it facilitates impact management, build continuity into the environmental and social impact assessment process and help to optimize environmental benefits at each stage of the project development. Environmental monitoring program has been prepared for the proposed project for assessing the efficiency of environmental management plan implementation and to take correction measures in case of any degradation activity in the surrounding environment.

In order to have minimal and acceptable residual environmental and social impacts, and enhance the potential, a total Environmental mitigation cost is estimated to be **4,053,500.00** and necessary follow up of their effectiveness should be made through well planned monitoring programs with the cost of

300,000.00 Birr per the planned year and a total of Birr **4,353,500.00** for consecutive five years by concerned stakeholders to have minimal and acceptable residual environmental and social impacts and enhance the potential benefits.

Table 1: Summary of environmental impacts, mitigation measures and management plan

S#	Potential impact	Mitigation measures	Project phase	Time frame	Responsible Institute	Budget (Birr)
1	**Biological Environment parameters**					
	Impacts on the existing flora and fauna Loss of flora	-Avoid cutting indigenous trees and vegetation within the survey area/ path of the water conveyance -Avoid excessive bush clearing; where possible adopt re-vegetation around the water intakes -Minimize number of indigenous trees cut -A forestation and reforestation programs in certain parts of farmlands -Preserve certain sections for grazing purposes The integrity of the forest resources should be well guarded from the spillover effects of the project‟ activities so as to maintain their functionalities	Construction and operation phase	Post operation season	Project owner and contractor	230,000
	Loss of fauna	- Construction within sensitive habitats should be avoided at all costs	Construction	Preconstruction season	Project contractor	Nil

S#	Potential impact	Mitigation measures	Project phase	Time frame	Responsible Institute	Budget (Birr)
		-Wetlands should be buffered by a minimum of 50 meters -Construction zone should be clearly indicated to prevent off site damage - Modifications of canal routes should be preceded by an ecological survey - There should be intensive tree planting - Setting aside woodlands				
	Destruction of Wildlife habitats	-The habitats diversity should be retained and protected by conserving them -There should be no cultivation on riparian sections since they serve as habitats for several animal species -Woodlands should be adequately established	Construction and operation	During construction season	Contractor and project owner	Nil
	Risk of Alien species, pests and aquatic weeds	• Managing canals so as to minimize weed growth.	Operation	Post-operation season	Project owner and local benefices	455,000

S#	Potential impact	Mitigation measures	Project phase	Time frame	Responsible Institute	Budget (Birr)
		• Avoiding stagnant water points that suit for aquatic weeds. • Monitoring and removing weeds before they spread and clog canals. • Keeping dry canals, drains and fields when crop watering is not required. • Implementing improved drainage and efficient water applications. • Use of resistant crop varieties. • Use of chemicals as the last option.				
Pollution-concern						
II	Air and Dust	-Provide dust masks to workers -Sprinkle water on the soil during excavation and land filling; -Control speed of working machinery	construction	During construction season	Project contractor	135,000
	Noise	-Abate noise by sensitizing drivers in the project -Use manual labour as much as possible. -Restriction of activities to daytime	Construction	During construction season	Project contractor	Nil if mitigated as proposed

S#	Potential impact	Mitigation measures	Project phase	Time frame	Responsible Institute	Budget (Birr)
		- Workers within the vicinity of high level noise to be provided with adequate PPE. -No idling of vehicles and machinery if not in use, they should be switched off. -Control speed and noise of construction machinery; -Insulate noisy machines and activities during construction to minimize noise impact to neighboring communities -Unnecessary hooting is to be avoided as much as possible				
	Water	-Keeping all equipment and machinery free from mud -having workable standard operating procedures while working along water resources -Apply appropriate irrigation procedures to prevent contamination -Sensible use of agrochemicals to prevent deposition into rivers -Adhere to waste discharge regulations -Compaction of loose material/soils -All repairs and maintenance work should be done at the contractors	Construction and operation phase	Post construction season	Project owner ,contractor and local community	Nil if it mitigated as proposed

S#	Potential impact	Mitigation measures	Project phase	Time frame	Responsible Institute	Budget (Birr)
	Water borne diseases	• Avoiding pollution of river water during concreting work from cement slag and oil and fuel spills by providing suitable diversion and/or other appropriate measures.	Construction	At the time of construction	Project contractor	Nil
	Water quality	• Use of environmentally friendly biocides. • Avoid releasing of drain or irrigation return water into streams and rivers. • Taking precaution in biocide spraying not to pollute water in the canals. • Conducting periodic water quality monitoring.	Operation	During and post operation	Project owner	Nil

S#	Potential impact	Mitigation measures	Project phase	Time frame	Responsible Institute	Budget (Birr)
Physical Environment						
III	Impacts on soils and Siltation	• Schedule construction for dry season. • Minimize compaction of soils and loosen compacted soils by plowing after Completion of works. • Provide appropriate cross and longitudinal drainage facilities including Lined side ditches for construction of any roads. • Refill the exposed or excavated soil soon after completion of works. • Keep land clearing and disturbance to absolute minimum. • Reduce the time surface remain bare following completion of works and establish vegetation cover on exposed areas/soils with appropriate vegetation. • Follow up and maintenance of erosion protection measures on roads, canals and drains. • Distilling program to clean silted up structures. • Efficient land and water management to reduce erosion.	Construction and operation	During and post construction	Contractor And project owner	1,200,000

S#	Potential impact	Mitigation measures	Project phase	Time frame	Responsible Institute	Budget (Birr)
	Impacts on landscape and visual amenity, and slope stability	• Minimize side-casting of excavation materials on down-slope. • Restore borrows sites, materials processing sites through back-filling, landscaping and re-establishing vegetation cover. • Replant and maintain vegetation to restore the natural appearance of construction areas. • Preserve the vegetation cover of the areas unsuitable for irrigation and implement enhancement measures.	Construction phase	During operation And maintenance season	Contractor of the project	300,000
	Sedimentation	• Implementing soil conservation measures in the catchments and command area to reduce soil erosion and sediment loads of the canals.	Operation phase	post operation	Contractor of the project	Nil

S#	Potential impact	Mitigation measures	Project phase	Time frame	Responsible Institute	Budget (Birr)
	Siltation and farm flooding	-Ensure proper design and layout of field to avoid canal on the steep gradients -Ensure there is appropriate terracing where possible -Ensure water application does not exceed soil intake rate, over irrigation	Construction	Post construction	Contractor of the project and project consultant	Nil
	Salinization/ Leaching	-Avoid water logged conditions, where possible -Add humus and organic manure to the soils regularly	Operation	Post operation	Project contractor and benefices	Nil
	Water Quality concern	• Avoiding pollution of river water during concreting work from cement slag and oil and fuel spills by providing suitable diversion and/or other appropriate measures.	Construction	During construction	Project contractor	Nil
Socio-economic and institutional settings						
	Land Repossessions and Relocation	• Stakeholder consultation and involvement in decision making at all levels ✓ Compensation of land to the farmers ✓ Provision of alternative land of similar value ✓ Skip areas where the crops are maturing to cut on the losses Measures to reduce loss of income to those affected by the relocations	Construction	Post construction	Project owner or the contractor as per the agreement	1,000,000

S#	Potential impact	Mitigation measures	Project phase	Time frame	Responsible Institute	Budget (Birr)
IV	Labor migrants pressure on scarce social service and employment	- Provision of alternative and additional social welfare - prioritizing both the skilled and semi- skilled local labor - a head population planning and its consideration with the inhabitants - Expansion of available social service - Monitor the trend in migration to the area during the project implementation and increase the requisite facilities	Construction	Post construction And operation	Contractor, project owner and local government structures	Nil
	Health effect on the nearby society	- Implement awareness creation of eminent social evils such as HIV/AIDS and other STDs - Organizing community sensitization drives on the prevention and management of the HIV/AIDS - Liaising with the local organizations for the training and education on the right prevention mechanisms - Contraceptives should be provided at acceptable locations	Construction	Since construction and post operation	Project owner, relevant stakeholders and contractor	Nil, Part of the woreda annual health budget

S#	Potential impact	Mitigation measures	Project phase	Time frame	Responsible Institute	Budget (Birr)
	Impact on the existing urban land use pattern	- Exclude lands assumed by future urban land use plan - Search alternative irrigable land outside the urban fringes in the extensive cultivated land - Relate the project land use plan with the existing urban future plan and over to exclude some affected area.	Preconstruction	During designing time and construction	Project consultant, contractor	Nil if the proposed action is applied
	Use of canal water for domestic purposes	- Sensitize the community on the dangers of using canal water for domestic purpose - Consider the possibility of providing tap water - The local community should be encouraged to treat the tap water. - Ensure there is adequate sanitation facilities to be installed on sites - Warning signs/bumps to be erected and/or placed at risky points - There should be insurance covers for the workers under the work man's - Install at strategic points enough firefighting equipment	Operation	Post construction	Project owner, the public and relevant stakeholders	Nil part of the woreda's budget

S#	Potential impact	Mitigation measures	Project phase	Time frame	Responsible Institute	Budget (Birr)
	Possibility of Increased Conflicts	- Avail drinking points for the livestock along the canal or build the water pans along the canal - Fencing off the farms to prevent animals entry into the farms - regular communal discussions and dialogue should be facilitated between to bring about mutual agreements between various land users Other modes of grazing could be encouraged such as zero grazing as it is less pasture demanding - Fodder production can be done on irrigated land to reduce the pressure of over grazing - establish local bylaws and irrigation management structures to handle the conflict	Operation	Post construction	Project owner, use community and wereda concerned offices	Part of the integrated project cost
	Institutional capacity building on irrigation/ water management	- Along with the introduction of surface pump irrigation, the capacity of the irrigation sector has to be built on irrigation/ water management through HRD, Training, equipment, etc.	Operation	Post construction season	Project owner, wereda relevant offices	500,000

S#	Potential impact	Mitigation measures	Project phase	Time frame	Responsible Institute	Budget (Birr)
	Water related Health hazards	- Avoid creating pools of water where insect vectors of diseases may breed. - Provision of adequate safe water supply, sanitary facilities, and health services for the project workers and local population. - Provision of adequate impregnated bed nets for the population in the project area. - Spraying the houses in the project area with insecticides.	Construction	From construction to implementation season	Contractor, project owner and wereda relvant stakeholders	Nil, part of the integrated wereda and project running cost
	Extended malaria Season and increase schistosomiasis	- Malaria diagnosis, treatment and management skills upgrading for frontline health workers - Repeated mass treatment of local population - Benet programme including LLIN distribution, education and training, and monitoring	Construction	Construction and post operation season	Contractor and wereda health office	Nil, part of the wereda‟s annual health cost
	Impacts of transformation of livestock husbandry System.	- Continue implementation of the livestock programme as a major project component - Establish livestock corridors between fields	Operation	Post operation season	Project owner, beneficares and relevant wereda stakeholders	Nil

S#	Potential impact	Mitigation measures	Project phase	Time frame	Responsible Institute	Budget (Birr)
V	Climate change incident	- Plan irrigation systems to address ways and means of reducing GHG emissions without jeopardizing the beneficial effects of irrigation project. - Search research findings on devising ways and means to reduce GHG emissions, irrigation could become environmentally sustainable adaptation measure under climate change.	Preconstruction	Throughout project cycle	Contractor, project owner, EPA, local community and relevant stakeholders	Nil cost its sharing of legal responsibility
		- Encourage forestry Actions*:* encourage tree planting on the hills, community and private land and develop better management of forestry operations as trees absorb and store atmospheric CO2 and avoid forest fires not to release CO_2 - Minimize the off-take of woody biomass for construction and fuel and use other alternatives such as stoves, electricity, stones and cement concrete breaks instead of wood for house	Operation	Post construction	project owner, EPA, local community and relevant stakeholders	Nil cost its sharing of legal responsibility

S#	Potential impact	Mitigation measures	Project phase	Time frame	Responsible Institute	Budget (Birr)
VI	**Cumulative Downstream Effects**					
	Inadequate information for Planning	- Continue implementation of available information and prioritizing the establishment of hydrological monitoring and information systems.	Design	Preconstruction season	Project Consultant	Nil, part of the project detail study
	Low , Insufficient water to down users	- Ensure the minimum release to the lower riparian as high priority - Develop an integrated water resources management (IWRM) plan based on actual hydrology. - Include a multi-stakeholder rule-making mechanism in the IWRM plan.	Operation	Since operation and maintenance	Project owner, users association	Nil, it needs effective management
	No environmental flow consideration	- Determine environmental flows for the river basin using multi-stakeholder process.	Design	Pre construction	Consultant and project owner	200,000
	Reduced dry-season flows	- Regulate (augment) dry season flows at border using water regulating mechanism	Operation	Post construction	Contractor and users association	Nil cost

S#	Potential impact	Mitigation measures	Project phase	Time frame	Responsible Institute	Budget (Birr)
	Affect downstream water transport and economic tie of the riparian	- Consider the environmental flow and hydrological balance of the river basin by which that tolerate this effect. - The water balance, crop water requirement and other utilization strategies under the Tekeze River should consider and respect the use-right and some domestic, navigation and existing downstream irrigation practices of the riparian countries.	Design	Preconstruction	Consultant , contractor and water users association	Nil, utilization management arrangement need
Overall project mitigation cost			Project major impact's enhancing measure **cost=3,685,000**			
			Contingency (10%) **=368500**			
			Total project Environmental cost **=4,053,500**			

Chapter XII. Conclusion and Recommendation

Conclusion

This study has been carried out to equip the client with relevant and sufficient information about the proposed irrigation project of THIP irrigation scheme on how the project could be environmentally safeguarded. It is anticipated that the proposed development project would bring substantial economic benefits not only to the local communities within the project area, but to the entire nation as a whole. The negative environmental impact that may occur during the implementation of this project is minimal and could be addressed by implementing the mitigation measures to ensure that they pose no threat to the environment and communities. The mitigation measures are going to be carried as part of the project component activities and will bring in some fair cost in the implementation process. The benefits of implementing the project are enormous and will address persistent problems of irrigation water shortage in the project area that has affected the communities for a long time. Typically, the Tekeze Humera Pump Surface Irrigation Project can bring about a number of short and long term benefits like:

- ❖ Enhance agricultural productivity and food security and reduced poverty
- ❖ Create huge seasonal and permanent job opportunity
- ❖ Improved social and physical infrastructure
- ❖ Improve living standards of the people
- ❖ Efficient use of land and water resource
- ❖ Increase income
- ❖ Gender encouragement and benefits

To the contrary, this project could also bring about different adverse impacts both to the natural environment and the community which tend to appear during the project construction and operation phase. Accordingly the major adverse negative impact of the project can be summarized as:

- Bio-physical (impacts on water, air, land , forest, soil and wild life)
- Socio-economic and cultural
- Institutional and
- Downstream effects are the most common impact category of the THIP.

Among the adverse impacts the following found to be significant: loss of vegetation and land degradation, affect the nearby urban land use pattern, health issue especially the spread of malaria, water quality concern that could affect by agro-chemical misuses, impact on ecologically sensitive areas, water logging and poor drainage, displacement and relocation of land and people, loss of grazing land and health and social safety issues, and the downstream effect are among the significant.

Despite of this, majority of the negative impacts can be reduced to acceptable levels, except some immeasurable factors through integration of environmental mitigation measures in the design or planning and implementation of the project. Therefore, it can be concluded that there will be no irreversible or unmitigable impacts that will prevent the implementation of this irrigation project when the recommended mitigation plan is properly implemented.

In relation to its social acceptability, stakeholder and public consultations concerning the THIP had been conducted at different level including woreda and community levels. Due to this, the outcome revealed that there is high acceptance for the proposed irrigation project. This is largely based on the expectations that there will be opportunities for substantial increase in agricultural production and employment for local people, and thus, increased income level and improved living standards. They believed that implementation of the proposed project would bring significant improvement in the socioeconomic status of the community and such benefits will significantly contribute to the overall economic development of the region and the country. Even to such extent, the local people of the PCA showed their willingness to contribute any share which they could for the better implementation of the project. In spite of this, they also insisted and demanded about the need for equivalent substitution of their farm land and some infrastructure lost on time, the need for fair distribution of irrigation water, eagerness to early implementation of the project and public health risks especially the aggravation of domestic diseases like malaria.

Finally yet crucially, since the negative environmental impact on the implementation of this project is minimal and could be addressed by implementing the mitigation measures proposed, the project is found to be socially accepted economically feasible and environmental friendly. Thus it is rational that this project is better-off to implement and the project proponent and relevant stakeholders and the local community should play their role for the sustainability of the project.

Recommendations

In the previous topics the assessment indicates that different strategic actions should be taken to help ensure the project's feasibility and enhance its sustainability by proposing various environmentally sound mitigation options and enhancement measures and its implementation monitoring parameters. However, still there are sensitive and prioritized crucial issues of the study that need special attention through the project cycle. Accordingly the following issues demands great consideration.

It is important that during the implementation, the project proponent should be actively involved to address some of the cross cutting issues such as, natural environment, air quality, biological environment, health, socio-

economic and other relevant issues for their mitigation. Moreover the stakeholders also should take part to ensure that emerging issues are tackled as they come.

- The project is a bold attempt to transform agricultural production methods and yields and at the same time radically change living conditions in a poor and socially semi-rural society.
- The issue of riparian use right and the projects best and harmonizing approach should be adapted to avoid future project jeopardizing factor and to settle conflict on water resource utilization of the Tekeze river basin.
- Majority of the project command area lay under the existing and proposed towns of future urban plan expansion area and investment sites (like in Humera town, Adebay, Rawiyan and May Kadra). This could be controversial and clash with other development efforts. Thus the proposed urban expansion area should be excluded and instead there is a plenty of cultivated land outside this impact zone that could be included early before operation.
- There is no previous experience of successful implementation of such mega project in large scale, modern and commercial based project in the area. Therefore the issue of institutional risks is significant and capacity building should be done harmoniously.
- The project command area (i.e. western Tigray and that of Kafta Humera Woreda) is among the few areas of the country by which ecologically sensitive and biologically endangered reserve areas and flora and fauna diversities are found and because of this the recommended mitigations for such specific zone would be expected to avoid the adverse impacts or reduce it to the minimum.
- The ecological balance of the Kafta Humera National Park could be disturbed. For the sake of this the planting of pump station and main canal design should consider noise pollution, forest degradation and the impact of altering of the usual wild life movement routes.
- The issue of water born and related diseases in the project area is serious, especially malaria is endemic. Such surface irrigation project could aggravate the incident rate of Malaria and due to this the project owner, contractor and other relevant stakeholders should be made aware early to mitigate it.
- Majority of the PCA inhabited by different member of community which were immigrated by integrated resettlement programs in the previous years. Thus serious attention should be given not to re-displace and relocate such unstablized community.
- There are minority groups of Kunamma community in the project area who had been leading their livelihood as semi-pastoralist later changed to mixed agriculture. They have no irrigation practice and experience and hence they should be treated in special capacity building program.

- There exist similar projects in the study area mainly focusing on potable water supply but sitting of similar projects at same geographic area of interest would probably affect each other so a harmonizing mitigation approach to correlate both projects should early identified.
- Establishment of an efficient water application/management system to irrigation fields is important in order to prevent adverse soil modification like water-logging, and creation of mosquito and snail breeding sites.
- Such mega irrigation project is likely to utilize bulky agro-chemicals like pesticides and insect sides. Thus a proper handling and use of agro-chemicals is recommended in accordance to environmentally friendly approach and acceptable relevant guidelines.
- Enhancing market oriented production system using production enhanced technologies that lead to agro-industrial development.
- Establishing a monitoring program for checking the critical parameters like environmental flow of the river, trans boundary effect, water quality, relevant soil characteristics, groundwater level, water-logging, and disease vector breeding places.
- The commitments of the key stakeholders including the Bureau of Agriculture, Tourism and Culture, Water Resources Bureau, Woreda and Kebele Administrations, Agriculture Offices, and Health Offices to implement the mitigation measures specified in the EMP and other necessary actions will be vital.
- For further project sustainability reasons this project needs additional future public disclosure and stakeholder consultation phase in order to resolve arising problems timely.
- Finally, but importantly it is important to note that to secure the effective implementations of such bulky measures allocating the necessary resources remain among the critical governing factors .

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ACRONYMES

ABA	Abay Basin Authorities
ADLI	Agricultural Development Led Industrialization
a.s.l	above sea level
BBM	Broad Bed Maker
BoEPLUA	Bureau of Environmental Protection Land Utilization and Administration
CBD	Convention on Bio-Diversity
CSA	Central Statistics Authority
DSS	Decision Support System
EC	Electro Conductivity
EEPC	Ethiopia Electric Power Corporation
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EMMP	Environmental Management and Monitoring Plan
EIS	Environmental Impact Statement
EPA	Environmental Protection Authority
EPC	Environmental Pollution Control
ESMF	Environmental and Social Management Framework
EWLCA	Ethiopian Wild Life Conservation Agency
FAO	Food and Agriculture Organization
FGD	Focus Group Discussion
FDRE	Federal Democratic Republic of Ethiopia
GCP	Ground Control Point (GPS)
GDP	Gross Domestic Product
GHG	Green House Gasses
HQ	Head Quarter
IBA	Important Birds Area
IEE	Initial Environmental Evaluation
ILO	International Labor Organization
KHWWMEO	Kafta Humera Woreda Water Mining and Energy Office
KSNP	Kafta Sheraro National Park
MoARD	Ministry of Agriculture and Rural Development
MoWE	Ministry of Water and Energy
PCA	Project Command Area
PIT	Project Implementing Team
PKWSO	Project kebelle Water Supply Office
POPs	Persistent Organic Pesticides
REA	Rapid Environmental Assessment
SDPRP	Sustainable Development and Poverty Reduction Programme
STDs	Sexually Transmitted Diseases
SWC	Soil Water Conservation
TDS	Totally Dissolved Solids
THIP	Tekeze Humera Irrigation Project

TOR	Term of Reference
TWEO	Tabia Water and Energy Office
TWRB	Tigray Water Resource Bureau
TWWDSSE	Tigray Water Works Design Study and Supervision Enterprise
UNCCD	Unite Nations Convention on Combating Desertification
UNFCC	Unite Nations Framework Convention on Climate Change
WB	World Bank
WHO	World Health Organization
WRMA	Water Resource Management Authority
WRM	Water Resource Management

1. INTRODUCTION

1.1 General overview

Economic, social and environmental change is inherent to development. Whilst development aims to bring about positive change it can lead to conflicts. In the past, the promotion of economic growth as the motor for increased well-being was the main development thrust with little sensitivity to social or environmental impacts. The need to avoid adverse impacts and to ensure long term benefits led to the concept of sustainability. This has become accepted as an essential feature of development if the aim of increased well-being and greater equity in fulfilling basic needs is to be met for this and future generations.

An EIA may be defined as formal process to predict environmental consequences of human development activities and to plan measures to eliminate or reduce adverse effects. EIA provides a unique opportunity to demonstrate ways in which the environment may be improved as part of the development process. It provides an opportunity for mitigation measures to be incorporated to minimize problems. EIA is a management tool for planners and decision makers and complements other project studies on engineering and economics.

It is important that an EIA is not just considered as part of the approval process. A key output of the EIA should be an action plan to be followed during implementation and after implementation during the monitoring phase. To enable the action plan to be effective the EIA may also recommend changes to laws and institutional structures. Initially EIA was seen by some project promoters as a constraint to development but this view is gradually disappearing. It can, however, be a useful constraint to unsustainable development. It is now well understood that environment and development are complementary and interdependent and EIA is a technique for ensuring that the two are mutually reinforcing.

Water resource development project (i.e. Irrigated agriculture) is crucial to the economy, health and welfare of a very large part of the developing world. Water resources development projects thus have major impacts on the environment. It is necessary to determine the acceptable level and to compensate for the environmental impact. The impacts may be both to the natural, physical environment and to the

human environment. All major donors consider water resources development projects to be environmentally sensitive.

Irrigation and drainage projects invariably result in many far-reaching ecological changes. Some of these benefit human population, while others threaten the long term productivity of the irrigation and drainage projects themselves as well as the natural resource base owing to the potential for conflicts arising from the local communities affected. The undesirable changes are not solely restricted to increasing pollution or loss of habitat for native plants and animals; they cover the entire range of environmental components, such as soil, water, air, energy, and the socio-economic system.

The principle of environmental screening of development projects at the planning stage especially through conducting EIA has been stipulated under EIA proclamation No. **299/2002** which helped to conserve resources wisely for sustainability. Multi- and bilateral funding agencies also demand EIA as prerequisite for lending, technical assistance and development support. This EIA study for the Tekeze Humera irrigation project has been prepared in compliance with policy and legal procedures of the country, internationally approved laws and the African development bank safeguard system requirements to ensure environmental impacts are managed and sustainable use of the resources is secured.

1.2 Project background

Though agriculture remained as the dominant sector of the economy it is being practiced mainly as rain fed agriculture, due to lack of water irrigation and large spatial and temporal variations in rainfall farmers could not produce more than one crop per year and there is frequent crop failures resulting in chronic food shortage. It is stated that the western part of the Tigray region specially that of Kafta humera Woreda is highly endowed for irrigation potential but due to lack of reliable study and tangible implementation this was not effectively utilized yet. The proposed project is meant to provide reliable alternatives sources of water so as to promote the development of irrigation agricultural crop production. This is meant to promote the streamlining of the already strained resources as a matter of planning and utilization of water. There are usually several overhead losses as a result of poorly developed irrigation channels and the proposed project is meant to improve water delivery patterns.

The proposed Tekeze-humera Irrigation Project (THIP) is located in Tigray Regional State, Western zone, Kafta humera Woreda encompassing six rural kebeles. The specific site is located in the lower limit of Tekeze river basin at a locality known by Heilegen and expected to irrigate about 30,000 ha of land using water from Tekeze River to main canals and subsequently distributed by sub-canals by gravity.

1.3 purpose of the study

The main purpose of this report is to evaluate the potential adverse effects either social, health, environmental or safety concerns that are likely to emerge from the proposed development irrigation and related activities to ensure sustainable development. An EIA for this matter therefore shall help in identifying, evaluating and predicting possible impacts of various development activities and thereby providing an opportunity to remedy against the identified negative impacts whilst ensuring the positive ones are enhanced.

1.4 Objectives and status of the EIA

This study is aiming at preparing a complete EIA report for Tekeze-Humera irrigation project (THIP) in accordance with the Ethiopian environmental policy and legal frame work as well as the African development bank safeguards Systems requirements and the following specific objectives have been examined in carrying this EIA report:

- Identify the type, nature and scale of the project;
- Identification and description of the baseline conditions including physical, biological and Social conditions;
- Determine whether the proposed project may bring about environmental impacts;
- Verify compliance with the environmental regulations and project's standards;
- Propose mitigation and monitoring measures in the form of applicable safeguard documentation to address potential impacts;
- Evaluate the existing institutional capacity of the project that can help to manage the recommendations for implementing the measures outlined in the Environment Management and Monitoring Plan [EMMP]

- Provide recommendations to build capacity and strengthen environmental management and awareness;
- Verify the adherence and compliance of the international laws, policies and regulations

1.5 Study approach and Methodology

There was an initial site visit to identify the scope to be addressed in the study. Various aspects that are relevant to the project were identified so as to be addressed in the study. The likely changes in different environmental parameters were analyzed against the established baseline information and the impacts described in both quantitative and qualitative terms. Based on the initial environmental evaluation (IEE) that was prepared prior the original full EIA study

Approach to Assessment: The methodology involved site visit and discussions with the residents of the project area, meetings with the affected stakeholders and questionnaires administered to households and key informants were conducted. During these visits a detailed examination of the ecological settings and measurement of several parameters of the area were done to set the baseline information. Initial site visits involved acquainting the team with the projects‟ background information including the site coverage, topography, soils, existing developments, concerns likely to be raised from the residents and a familiarization meetings with the provincial administration. In undertaking the EIA, a systematic approach comprising the following steps was adopted.

Screening of the project: a process that identified the project as being among those requiring a full EIA study under schedule 2 of the EIA proclamation No. 299/2002 and Scoping which identified the projects‟ key issues of concern to be addressed in the EIA.

Data source: the study team has exploited adequate data from different area of concern and project site and affected community have participated and consulted, the key approach were

(i) use of a multidisciplinary team ,

(ii) preparing clearly stated term of reference (TOR)

(iii) application of rapid environmental assessment (REA) on site,

(iv) impact screening , using matrix approach

(v) review of relevant secondary data /base line data/ of study area

(vi) focus group discussion with project affected community and local leaders

(vii) stakeholder consultations and participation

(viii) Reviewing of relevant environmental laws and standards

(ix) Reviewing previous similar projects experience in Ethiopia, and elsewhere

In formulating this report, the team has been guided by the criteria on 'Presentation of Information' in the Environmental Protection Authority's Review Criteria (EPA 2002), the African Development Bank Safeguard Systems as that of regional EPA.

Public participation and consultations, Extensive consultations with various stakeholders that are directly and indirectly affected by the project were conducted. Public consultations were conducted using structured questionnaires administered to households and public meetings to determine the acceptance levels of potential impacts and the opinions held by the affected and interested parties which latter was considered in the formulation of mitigation measures and formulate EMP.

1.6 Review of relevant documents and similar studies on the specific topic

To comprehensively organized and interpret this projects outcome different relevant international and national documents, relevant Policies, legislation and guidelines pertinent to environmental protection were gathered and reviewed. Previous EIS report on similar projects by Tigray Water Resources Bureau and other relevant studies were obtained and reviewed in order to adapt crucial relevant data.

1.7 Scope and delimitation of the study

The typical activities under the study include, collection of baseline data on existing environmental settings of the project area, analyses of the project activities and their respective impacts on the environment, identification of the environmental components that would be most affected by the project, propose feasible measures that would help to avoid and/or minimize the adverse impacts.

1.8 Study Limitations and constraints

The study has faced a number of challenges and constraints. Those which have had a significant effect on smooth implementation of the assessment process and on the quality of the analysis and outputs are. Among the major issues the following are the critical ones:

- Originally the project area has little similar earlier studies and therefore little documentation making it rather challenging.
- The weakness of base line data
- Busy and un committed local officials delayed meetings
- Un organized and un updated sector data which brought challenges to reorganize
- Lack of adequate time for more detail and complex study
- local government officials and experts unacquainted to the study
- Public and stakeholder consulting was not also an easy task because of initially fixed and congested schedules.

1.9 The EIA study contributors

The study was carried out by a multi-disciplinary team that comprises professionals in hydrology, geologist, soil expert, engineers, agronomist, geologist, surveyor, socio-economist parallel to the detail study of EIA and other similar important professional experts were consulted throughout the project's development phases.

CHAPTER II: PROJECT DESCRIPTION

2.1 General overview

The Tekeze Humera surface pump irrigation system is planned to irrigate 30,000ha from Tekeze River using pumping to higher elevation using gravity system. Tekeze Humera surface pump irrigation system is a project initiated by Tigray Water Resource Bureau and studied by Tigray Water Works Study, Design and Supervision Enterprise with great efforts for achievement of the plan to irrigate 30,000ha of land, which increase irrigated area through investments cost effective, environmentally and socially sound, and beneficial to the rural poor.

2.2 Objective and the Need for the project

The Feasibility Study's rationale for the project is that a transformation from subsistence, rain-fed traditional farming to an intensified, diversified and modernized agricultural system essential to improve the country's food security situation and create the conditions for sustainable development. Based on this rationality the project has its own major general and specific objectives.

The main objectives of the project are

- To assure the food security of the area as well as the region.
- To introduce manageable and efficient irrigation System.
- To produce cash crops this can contribute to the GDP growth significantly.
- To utilize the water sources efficiently for the development of the nation.

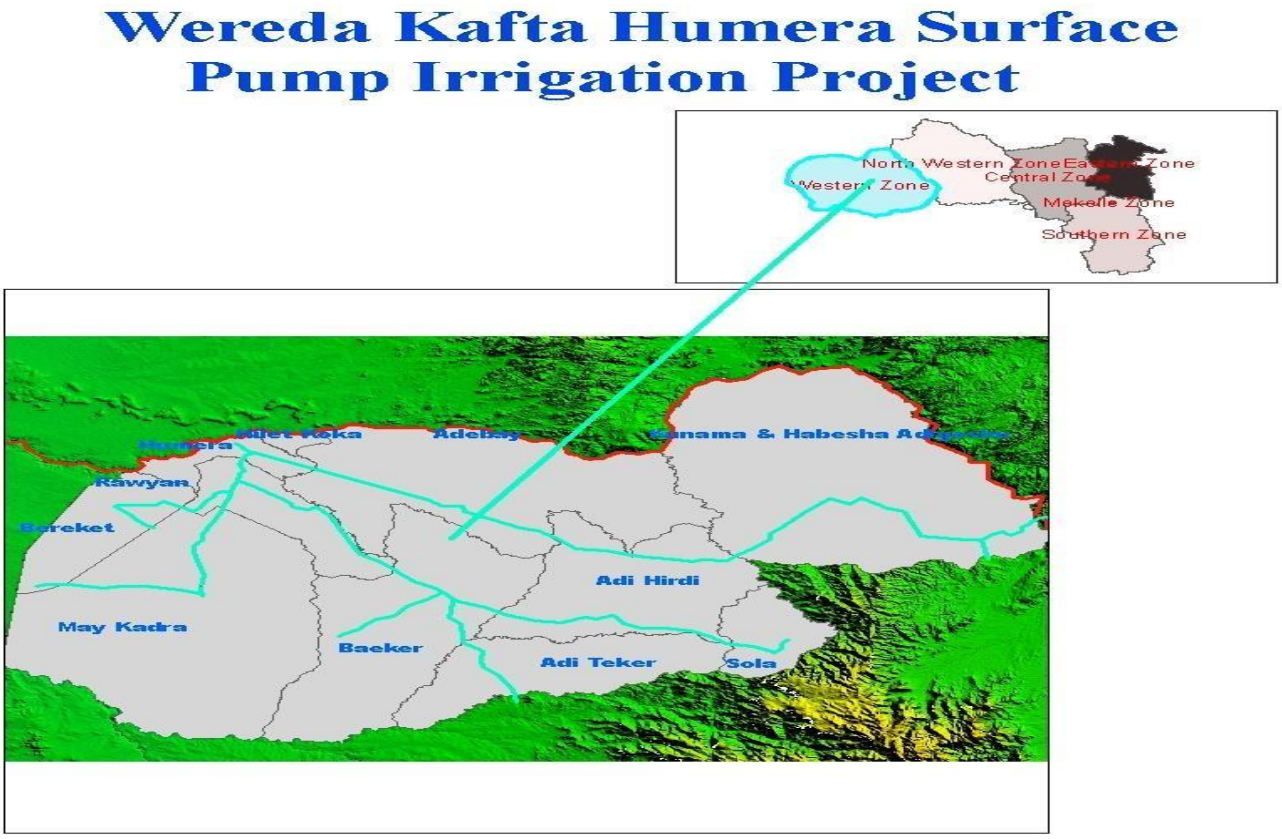
2.3 project merit and beneficiaries

It is expected to benefit the local community in transforming the sector in to sustainable and feasible economical rate of return and unlimited social benefits. Directly or indirectly the newly introducing about 30,000 ha irrigation project will be expected to benefit the project area community and the nearby society both in surplus production, income generation, job creation, ,economic diversification and formulating new market chain.

2.4 Geographical situation of the Project (Location)

The THIP will develop up to 30,000 ha on the southern part of Tekeze River, the potential site for pump stations is located north east of the humera town at about 30 km. Water would be released into the extensive plain farm land diverted from the river using canals downstream of the reservoir ponds, and then distributed by a primary, secondary and tertiary canals. Seven rural and semi-urban administrative kebeles currently utilized as cultivated land but nearly situated around urban-periphery of the humera town fall under the project mandate area.

Figure 1: Map of the project Woreda



2.5 Project detail technical activities

In this sub-chapter of the project the major detail and technical activities of the project like operation, management, maintenance, selection of pump station , design and its criteria, intake structure, reservoir and canal layout , pound reservoir and canal design and structure also technical specification and the project over all engineering cost estimation will explained and manipulated accordingly.

2.5.1 Project operation, maintenance and management

This involves the conveyance and water distribution to farmers in the project area so as to meet the water need for the farmers in the area so as to provide adequate water to individual farmers. The main objective of the conceptualization of the project is to streamline water supply to the farmers so as to

prevent water wastage and thereby managing the little water available to both the upstream and downstream farmers alike. The objectives of the project operation include:-

i. To ensure there is equitable water distribution among the various water users, both upstream and downstream and thereby preventing the occurrence of conflicts,
ii. Ensure the adequacy of the available water so as to prevent possible depletion of the same,
iii. Ensure there is a reliable water supply of water as per the distribution plans and
iv. To ensure there is efficient use of water so as to optimize the abstracted water.

There is an apparent need to ensure there is sustenance of the project for future usability. The quality of the construction and how the infrastructure is maintained is paramount to the project's continuity. There is therefore the need for regular maintenance and periodic rehabilitation to sustain its functionality and to prolong the lifecycle of the project. Maintenance includes routine, emergency and modernization depending on the scope and frequency of the maintenance. Routine and regular maintenance consists majorly of activities that need to be carried out throughout the project's lifecycle to maintain the infrastructure, structures and the irrigation equipment in a state that is operational and efficient.

Project improvement and maintenance will involve planned long term maintenance so as to improve water delivery to individual farmers and thereby improving water conveyance systems and water irrigation technologies that enhance water saving. In future, these activities may involve system redesign, canal lining and expansion of the infrastructure and the use of water efficient methods such as drip irrigation in place of furrow irrigation that has the potential for water wastage.

The agricultural office in the area has intensified training on on-farm water management trainings where farmers are trained on various water management patterns. There has been irrigation scheduling so that all farmers are well served by the water. This has promoted coexistence since various water users are efficiently served both upstream and downstream. There is training on crop husbandry that order to have a good return in terms of quantity and quality to the farmers. In addition, the area agricultural officer in consultation with the WRMA has promoted the implementation of the various by-laws so as to optimize water abstraction and further avoid water wastage. The management of the project involves decision making for irrigation water allocation among the various water users especially the upstream versus the downstream users. Waters sources may also have to be managed through the conveyance of

water to the farmers, water distribution to farmers, water allocation and application and the removal of the surplus when it is necessary. There has been intensive information passing on the need to follow the by-laws put in place so as to ensure there is an effective water use and management.

2.5.2 Preliminary study and design of the irrigation system

The following consecutive sub sections present the preliminary design results of irrigation system. The major purposes of this section are thus to describe how the design of the project complies with the prescribed design criteria to present the results of physical and hydraulic analyses and justifications for the sizing of system components such as Pound reservoirs, intake structures, irrigation infrastructures and main line. Physical and hydraulic analyses and justifications for the sizing of system components such as Pound reservoirs, intake structures, irrigation infrastructures and main line.

2.5.3 Design Criteria for all Main Lines

All main lines running from water source to reservoirs need to full fill the following points:

- All water to be lifted through the pipes must flow according to the design factors
- The pipes should accommodate the design discharge and head
- The flow velocity in the pipes up to 2 m/s
- The pipes need to be available in market
- The pipes should resist all live load and dead load during services
- All pipes are not empty when the pump stops i.e. the water in the pipes must start to flow immediately to the reservoirs as the pump lifts water. This will reduce or avoids the time gap for flow of water from pumps to pumps etc.

2.5.4 Intake Structure

The intake structure is found up Stream of Tekeze-River to supply water for the first pump station. Intakes are provided whenever water is withdrawn from surface source such as lakes, canal, rivers, or reservoirs. There will be an approach channel through which the water will flow towards pump stations.

At the entrance of the approach channel there are gates which are used during flood season to avoid entrance of flood in to the pump station as it will destruct the pumping plant. The water to be delivered to the pumping station must pass through trash rack which avoids entrance of sediment and debris.

2.5.5 Pound reservoirs

The ponds are required to store partially and to regulate the water from intake to the field (command area) to pump from Tekeze River to the command area of 30,000 ha. The water ponds will be constructed both in cut and fill areas and water pressure will be balanced by a compacted soil. The volume of the pond has been decided by taking 30 minutes of water to be reserved in it. This is because adding additional time to the pond will increase the volume and the amount of water reserved in the pond will not satisfy all command areas for longer time. The position of the pond was decided to incorporate more irrigable land as compared to the other position of the pond. The shape of the pond intended to be constructed is trapezoidal and the inlet and out let position of the pipes are in the direction of the farm and in the direction of the pump site. The location of the ponds is along the main pipe line route at peak positions.

The main objective of the pond is not to store irrigation water but to keep the system safe during blockage of the system i.e. if there is sudden blockage of the system while in operation, the water that comes out from the pond remains in the pond rather than pushing the water in to the system like on line system with pump.

2.5.6 Pump station and power house at the water source

The report includes electromechanical works of two pumping stations since their property and objective is the same. The pumps also have similar pumping capacity. In order to pump the required amount of water from the river, there should be well designed pump with a properly coupled driver. The pumps shall fit with required discharge and head. Therefore, the pump used for irrigation purpose shall be selected carefully to fulfill the necessary specification.

2.5.7 Canal design and structures

The farmers adopt total project efficiency of 47.2% for design of canals considering lack of irrigation experience. However, this irrigation efficiency is expected to increase with time as they get well acquainted with the irrigation operation. Considering the above efficiency, the crop water requirement (duty) calculated is 1.9 liters per second per hectare. Canal capacity is fixed based on the command area that is delivered by the canal.

CHAPTER III: ENVIRONMENTAL SETTING OF PROJECT AREA

3.1 Project Area description

In this part the different environmental factors and settings like physical, biological and socio-economic parameters variables like, location, topography, geology, climate, soil, ecological balance, hydrological setting, demographic dynamics, economic trend, health and water supply, education and health status, energy use and infrastructure enrollment are among the basic issues to get emphasis.

3.2 The physical environment

3.2.1 Location and topography

Geographically, the project area Kafta Humera Woreda is located in the western zone of Tigray regional state. Which lays in western most limit of the region and it borders with Eretria in the north, welkayit in the south, Tahtay Adyabo woredas in the east and with Sudan republic in the western. In a relative location the project area is situated about 20 km from humera town. Topographically it is dominantly plain area except some rugged terrain and shallow gorges in a few geologically unstable sites.

3.2.2 Topography, Geomorphology, and Potential geo-hazards of the study area

Like most civil engineering structures pumped irrigation systems require detailed knowledge of geological and engineering geological background of the foundation and construction materials. Geotechnical and engineering geological investigation and mapping mainly focus towards understanding the interrelationships between the geological environment and the engineering situation; the nature and relationships between the geological components, the active geodynamic processes and

the prognosis of processes likely to result from the changes being made (UNESCO, 1976). Geological and structural investigations were held in the field paying particular interest to the physical properties of the soils, discontinuity and weathering conditions of rocks. These studies were conducted using spot image, existing geological maps and check traverses along selected routes to ascertain the existence of certain lithology, and discontinuity structures in the field.

Tekeze - humera surface irrigation project is to be laid on the north western low lands of Ethiopia. Generally, the drainage density and pattern are mainly controlled by the lithology, topography and geological structures of the area. The drainage pattern of Tekeze – Humera area can generally be described as dendritic type and flows from South-east to North-west direction. Like most of the rivers in the region, their discharge usually consists of short lived flash floods during rainy season. Since the site is found farther from the Ethiopian Rift the site is not susceptible to considerable seismic activity for structural design and material selection. According to the seismic hazard evaluation carried out by Geophysical Observatory of Addis Ababa University (2004), the area found apart of rift valley and is not substantial for its seismic and volcanic activities.

3.2.3 Soil

Based on the field survey held and soil investigation done in the study area majority of the command area cover with a deep soil horizon which is greater than 150 cm .soil families of clay, silt clay loam and sandy loam are of the dominant share soil types in the command area this is also expected to result from ancient erosion system (by water and wind) and exfoliation and weathering of sediment rocks and some washed away top layers of highly eroded terrains. As a result through the transportation process of such degraded raw soil materials a deposit of matured soil layer tend to be formed in the majority of low land area.

As results had shown from field assessment the soil is black in color mainly with platy structure and some cracking soil behavior. The texture of the soils varied between loam, silty clay and clayey classes. The major soil types of the study area are: Vertisols, Arnosols, Cambisols and Regosols by studying and observing soil profile on pits and already existing gullies. The potential of command area with recommendable soil type and river water flow potential is about 30,000 ha.

In general the vertisols of Humera area contain 45% clay but near the valleys have sandy clay loam to sandy clay in texture. The clay nature of soil helps in retaining considerable amount of moisture and can give good crop yield with appropriate management. It has further been done by the soil and water conservation discipline increasing the observation densities in the already surveyed area with a view to increase accuracy.

All the land affected by erosion what is the difference is the degree of erosion. Similarly the catchments of the command area are not well terraced because of which the erosion hazards on the command area immense. So the runoff from the upper catchment has to be redirected to the natural drain.

Other than the sheet and rill erosion mention in the above from physiographic nature of the project area there is no major significant constraints of crop production activity in the project area, but soil fertility, and soil and water conservation measures are two basic factors that need due attention. Except the upper part and the left side of the command area is not significantly affected by out cropped rocks and shallow soil and has moderately deep to very deep soil thickness with a permissible slope for irrigation activities. Based on the assessment of topsoil texture, effective soil depth, topography, leveling requirement, drainage conditions, and slope majority of the command area is appropriate for irrigation purpose with some limitation on soil fertility, sheet erosion and drainage requirements of the soil.

Hence, soil management practices that improve soil fertility like addition of manure and artificial fertilizer, drainage systems with soil and water conservation measures are highly recommendable for the area to improve the existing productivity and sustainability of the land.

3.2.4. Climate and ago-ecology

Based on the data reviewed from the study Woreda agricultural and rural development office and other official documents of finance and economic development office of the Woreda at the year 2007 E.C, 78% of the Woreda lies within the Lowland 18% Mid highlands and 4% Desert agro climatic zones respectively. Western Tigray is characterized by the mono-modal type of rainfall which has a single maxima rainfall pattern. Humera Woreda and the project area receive the mono-modal type of rainfall and warmer climate.

Rainfall: Using the rain fall data is obtained from Humera metrological station, annual and monthly rainfall of the command area is estimated from 32 years records.

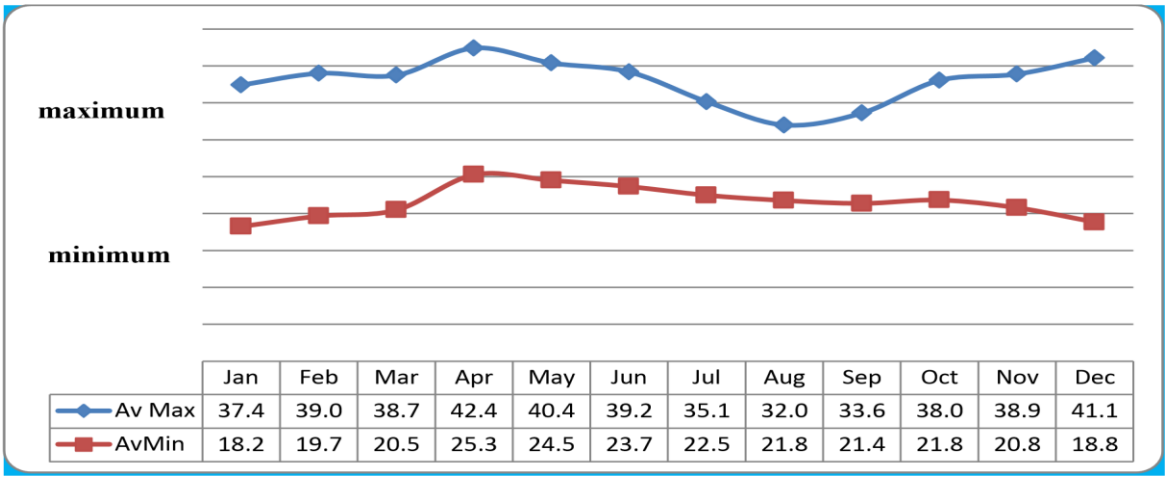
Table 1: Average monthly rainfall of the study area (1980-2011).

S#	month	Rain fall	S#	Month	Rain fall	Remarks
1	Jan	0.00	7	July	180	The peak rain fall pattern is recorded from June to September.
2	Feb	0.00	8	August	200	
3	March	20	9	Sept	140	
4	April	40	10	Oct	40	
5	May	60	11	Nov	20	
6	Jun	140	12	Dec	0.00	
Total			**Total**			

Source: Humera Metrological Station, 2015

Temperature: From the data, it is observed that mean monthly maximum and minimum temperature ranges from 32 degree centigrade to 42.4 degree centigrade and from 18.2 degree centigrade to 25.3 degree centigrade respectively. The average daily temperature is 29.8 ^{0}c. The maximum temperature reaches highest in April (42.4^{0}c) & Dec (41.1 ^{0}c) while the minimum temperature drops to the lowest in January (18.2 ^{0}c) which indicates that the area lies in tropical climate zone and hence the proposed crops are grown in this area.

Figure 2: Monthly maximum, minimum and mean. Temperature of the study area



Source: Humera Metrological Station, 2015

Furthermore, information from WOA, 2007 E.C., indicated that the distribution of rainfall is not uniform throughout the season. The rainfall pattern shows that supplementary irrigation is required during the months of June, September and October in the wet season while the dry season crops (Dec. - May) should only be raised with full irrigation.

Relative Humidity: The rate of evaporation and transpiration are accelerated on days of low humidity and slowed down during the period of high relative humidity. However, the relative humidity percentage is low to medium during the growing season; a greater use of water by plants may be expected.

The document reviewed by the federal water works indicated that the maximum relative humidity near of 25 years remained 71.8% in August while it was minimum in March (20.8%). the consumptive use of water by the plants is more when relative humidity is the minimum and the vice-versa. The agronomy study showed that the temperature is suitable for growing variety of crops including cereals, vegetables, and fruit crops using irrigation system. However, as PET (Potential Evapo-Transpiration) is always higher than the precipitation in this agro climatic zone, economic water management is vital.

3.2.5 Drainage pattern and Hydrological setting of the area

The study area, Kafta humera Woreda is highly endowed to its surface water sources. There are at least 8 major rivers, namely Tekeze, Bahre-selam, Ruwassa, Gytse, Rawyan, Degagum, Mayamsalu, Zerbabit and Aykdubish rivers, of which the first 5 are perennial rivers while the rest are seasonal rivers. Numerous streams are also drain from kafta highlands to the tekeze and other seasonal rivers of the study area. According to the geological and soil survey of the project, the majority of the command area is laid on plain to moderately sloping terrain. However, since the majority of the soil is clay soil there will be problem of water logging during rainy season. Therefore, it needs close supervision in managing excess water and to construct drainage structures by simple agricultural implements like Broad Bed Maker (BBM).

Hydrology is the study the occurrence, distribution, and circulation of Earth's waters as well as their chemical and physical properties and their interaction with the environment and living things. It is important in developing, managing, and controlling water resources. It deals with the following hydrological cycles and these are described in their respective units in this study.

3.2.6 Land use, land cover and environmental conservation

According the Woreda environmental protection, Land administration and use and that of agriculture and rural development offices official reports and reviewed documents shown, the total area of the Woreda is 717,000 hr, among this about 388,888.8hr (54.23%) is enclosed by cultivated land, 240,000 hr (33.47%) forest land , 51,972 hr(7.24%) grazing area, 35,344(4.93%) hr miscellaneous land use and

the remain 1456 hr (0.21%)settlement area though this the typical land use and land cover of the Woreda , every year there is tremendous land use change that tend to appear because of various economic and social phenomenon. Such event is reported to happen because of urban and settlement expansion, massive infrastructure and development projects arrival, cultivated land demand, huge investment need, construction and energy demand. In relation to the project kebeles land use and land cover profile it is not found so far differ from the Woreda existing setting. Due to this, the total area of the six project kebeles‟ is summed to be 319456.5hr. out of 155352 hr (48.63%) is cover by cultivated land another 87,000hr(27.23%) park area, 50,750 hr (15.89%) forest land, 25,153 hr (2.46%) grazing land the rest share 1201.5hr (0.38%) covered by settlement area .

3.2.7 Environmental conservation status

As far as the environmental conservation status of the area concerned it is a recent phenomenon in the area even when we comparing with the other part of the Tigray region it is recently before five years around 2001 E.C such rehabilitation activities massively started in the majority part of the Woreda including the specific project area. Due to this available data have given witness that, only few part of the total area is being in rehabilitation that is, 4928 hr physically and 2038 hr biologically a total of 6966 hr already conserved biologically and physically.

The ecological condition of the watershed has been disturbed due to inadequate management of the natural resources mainly the vegetation, soil and water. Even if significant portion of the main catchment area is registered as part of the Kafta- Sheraro National Park bordering the command area to the North west bordering Eritrea, still it is partially exposed to free grazing and encroachments but the condition of the park is improving. Many of the indigenous trees and shrubs species have existed adjacent to the National Park. However, much of fertile soil is washed away from the steep sloped hillsides of the catchment area closing to Qafta area. Such problem finally will lead to sever land degradation and hence reduction in productivity of land resources, thereby affecting the socio economic and environmental well-being of the community and aggravated flood sedimentation.

The watershed of the irrigation site that is outside the park boundary (i.e., the South Eastern direction of Kafta mountains/hills and farm lands, etc.), is in unprotected condition with pre dominantly frees

gazing; deforestation accompanied with very less/no conservation efforts. Grazing and sparsely distributed forests dominated by thorny acacia bushes has greatly influenced the command area.

Sheet, rill and gully erosion are observed in the command area. Therefore, construction of site specific soil and water conservation structures are essential to conserve and stabilize the command area. Sediments transported from hilly and unprotected lands have to be minimized. Otherwise, this will silt up the structure area and reduces the life span of the irrigation dam gradually. There are some soil and water conservation measures mainly stone bunds, check dams and enclosures but they are very minimal compared to the size and exposure of the of the catchment to land degradation.

Therefore an efficient and effective utilization of the existing land resources mainly of soil, water and forest resource is very important by proposing soil and water conservation measures that improve the irrigational status of the site. Hence, area closures of degraded forest/bush lands accompanied with physical conservation measures such as stone bunds, check dams and forest fire protection, thereby reducing transportation of sediments.

3.2.8 Water quality measure

The face of irrigated agriculture is changing with respect to water quantity and quality. In the not-to-distant past, neither irrigators nor agricultural crop advisors had to give much consideration to either the supply or the quality of irrigation water. Supplies of good-quality water, well-matched to crop irrigation, were plentiful, generally uncontested, and not necessarily closely monitored or regulated. However, growing competition for and accountability of the use of water have contributed to increasing scrutiny about just how water is used, how much water is available to the public for non-agricultural uses, and what practices impact the quality of our nation's water resources. Correspondingly, irrigators in many watersheds and irrigation districts have had to face and respond with changing practices to increasing scrutiny about how to best manage available water resources. Along with that has come growing attention to the quality of water available for irrigation.

Typically, qualities of irrigation water which deserve consideration include the salt content, the sodium concentration, the presence and abundance of macro- and micronutrients and trace elements, the alkalinity, acidity, and hardness of the water. Under some circumstances, the suspended sediment concentration, bacterial content, and temperature of irrigation water may also deserve attention.

Table 2. Summary of Irrigation water quality investigation for project area

S#	components	Measured Water quality	Potential adverse impact
1	Resistivity	2.8-3.0kΩ	None
2	TDS	186.24-204.8ppm	None
3	EC	0.291-0.32dS/m	None
4	Salinity	0.7%	None

Source: field measure for EIA

Accordingly, the EC value of Tekeze river course water sources in the project area is range between 0.341-0.395dS/cm and the TDS value of 186.24 – 204.8 ppm/l indicate a none salinity and proper ratio of dissolved total substances. The salinity ratio also range b/n 0.7-0.8% which is moderate and acceptable. Where as in comparison, the water quality around the command area by which the sample water is taken from sub-surface and ground water source contains relatively higher salinity nature and TDS value that ranges from 0.51to 1.21 dS/cm and a TDS value of 223.5 to 425.3 ppm/cm. however this does not mean it has a severe impact on the existing irrigation practices rather it can bring a moderate (medium) impact that can be mitigate in smart handling and selecting of preferable crop. To sum up, according to the FAO guideline, the water is suitable for irrigation and will pose slight to moderate salinity which can be managed by selecting crops favoring this range of the already measured salinity rate.

3.3. Biological Environment

3.3.1 Overview

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

Table 3. Biological diversity in Ethiopia

category	Number of known species in Ethiopia	Species endemic to Ethiopia
Higher plants	6,500-7,000	10-12 %
Mammals	277	31
Birds	925	29 (19 globally threatened)
Reptiles	210	9

Amphibians	71	24
Fish	*162	39
* Includes 10 exotic species		
Note: different sources give different numbers of species and endemics;		

Sources: adapted from EWNHS (1996), IBC (2005)

3.3.2 Flora and fauna

The western lowlands of Tigray and their surrounding escarpments account for large natural vegetation cover. Kafta -Sheraro National Park is among the vast areas with rich flora and fauna. However, since recently, the significant parts of the zone and the Woreda are appreciably degraded due to the growing intensity of human pressure. A wide spread deforestation is taking place in the area due to expansion of smallholder peasant cultivation, commercial farming and settlements. The natural vegetation types of the project area correspond mainly to altitude, topography, soil type and climate. The vegetation in the proposed irrigation areas is predominantly wood land, which is characterized by trees with fairly large deciduous leaves mixed or interspersed with small leaved trees. The dominant tree species are of Acacia species such as Acacia abyssinica, Acacia tortorilis, Acacaia nilotica and Acacia seyal.

The major tree species in the riverine habitat include *Tamarindus indica, Diospyros mespiliformis, Ficus sycomorus, Syzigium guineense.* In the wood land, the under-storey is mostly grasses. The main grass species found in the area belong to the genera: *Hyparrhenia, Echinocloa, Cymbopogon, Sorghum, Eragrostis, Cenchrus, Chloris, Eleusine and Pennisetum.* In most places the ground layer/grassland is grazed by large livestock population. In addition to the animals permanently found in the area, there is a seasonal movement of animals from the nearby tabyas during the wet season in search of grazing pasture.

In addition, the natural vegetation provides timber for agricultural tools, furniture and utensils, wild fruits and pollen grain for honey production. *Boswellia papyrifera* and *Acacia senegal* are among the economically important tree species found on uncultivable areas. In particular, these have commercial values as they are sources of aromatic resins. *B. papyrifera* is a source of frankincense/gum olibanum while *A. senegal* is a source of gum arabic. Presently they are widely collected in the western zone by many licensed associations. Accordingly, there are about six associations collecting incense to the central markets in the project area.

Figure 3: Endemic birds around the proposed Tekeze-river pump station area

Source: survey for EIA, 2015

3.3.2 Wild Life profile

The Subproject area does fall under some protected area or within the buffer zones. Many common flora and fauna are observed in the subproject area. Clearing of trees and some intervention to the common wild life reserve sites is seen for subproject works.

A detail site observation and assessment has been done, accordingly due to the intensity of human pressure, the wildlife resources of region are limited to some areas in the South Western Zone and to a few remnant habitats like the Kafta-Sheraro National Park. The park is neighboring the project area to the North West direction even part of the pump station/reservoir is crossing with in the park boundary. Though the kafta-sheraro national park is the most concentrated place for most of wild life in the study area and the region too there exist some fragmented sensitive ecological zones which serve as reservation of variety of wild life. Such places for the remaining wild life are protected forest, bush land, wet land (The Tekeze River), grass lands around the river and some other natural caves.

Many of these wild animal species are believed to have declined drastically over the past years due to civil unrest, drought, illegal hunting, expansion of cultivation and settlements. Due to intensive land uses for agricultural activities (cultivation and grazing) and settlements, only some pocket areas like that of National Park are left less disturbed around the proposed irrigation project area. These less degraded

habitats are found along the Rivers especially in the park area and in the steep sloping escarpments and hills. These areas support several species of mammals, variety of bird species and other fauna.

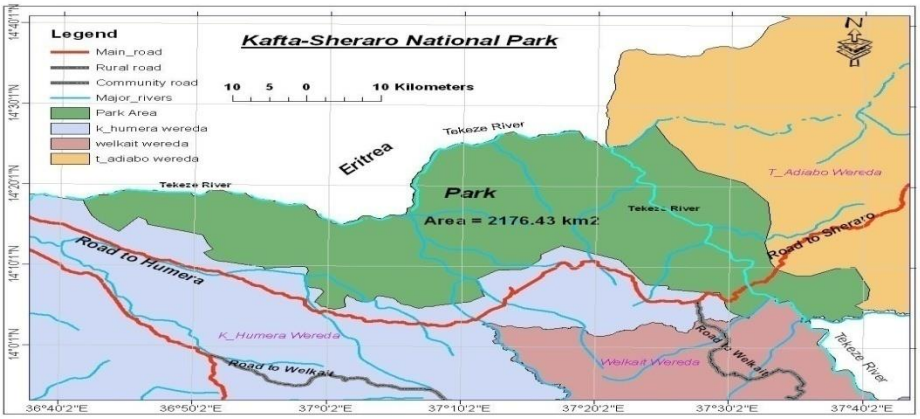
However, for wild animals in the project area that is apart from the park, the general trend for several species is a lowering of population size because of hunting pressure and habitat degradation due to expansion of cultivation and intensive livestock grazing. On the other hand, the number of some species particularly the primates like Anubis baboon and Vervet monkeys is abundant.

3.3.3 The Kafta-Sheraro National Park

The kafta-sheraro park is among the nationally recognized parks which had been established since 2007 GC found in Tigray region western zone lay between kafta humera and laelay Adyabo (Sheraro) which is 1015 km away from Addis Ababa on the main asphalt road NW from Shire to Humera which possess a unique physical feature of arid low land. The Kafta-Sheraro National Park Humera wing shares parts of the Adebay and Hiletkoka project Tabyas bordering the project sites. Hence it is important to assess the park in terms of wild life potential and conservation effects.

Geographical Location: The Kafta-Sheraro National Park is one of the most important ecologically conserved area, situated between 13°50'and 14°23' north and 36° 31'and 37°29'east, in the Kafta-Humera and Tahtay-Adyabo Woredas of South Western Zone and it has a total area of about 2176.43Km2.

Figure 4: Kafta-Sheraro National park



Source: Kafta-sheraro park office, 2015

Bio-physical environment: Initially the park had an area of about 5000 km^2 where as currently it shrinks to a total area of about 2176.43Km2.Based on the 2007 official inventories, some previous and recent assessments done, the Park harbors about 42 species of mammals (including elephant), 163 species of birds, and 9 species of reptiles.

Physically the park area is well known by its low land arid area dominated by extensive lower area due to this a number of mammals by which agro ecologically tolerated the local climate had been survived for a long period of time among these, greater kudu and African elephant are the key species of the park. Biologically the park is densely populated by various plant species, where by some of them remain endanger because of manmade and natural disasters.

A naturally endowed forest area is cover majority of the park due to this plenty of woody and grass species appeared massively. Majority of the park area forest is covered by wood land vegetation and previous studies reported about 37 plant species whereas according the official study done in 2014-2015 these number is reached to about 53 plant species according to the official report of Kafta-Sheraro national park office and other official documents. The NP is primarily known to refuge variety of ungulates and Gazelles. The area is also home to big games like Elephant and Roan antelope. Both species are rare in number so that require special conservation concern at present. Leopard and Lion were a common sight in the past but today exist with rare opportunities to observe them.

Table 4. Some of the wild life within the park area

S#	Local (Tigrigna) name	Scientific name	Remarks
1	*Harmath*	*African elephant*	*Endangered*
2	*Nay qolla agazen*	*Greater kudu*	
3	*Wundbi*	*eland*	
4	*Chelle ba'al game*	*Roan antelope*	*Endangered in Ethiopia*
5	*Mefles*	*Common warthog*	
6	*Sesha*	*Klipspringer*	
7	*Zibad*	*African civet*	
8	*Tera zibea*	*Spotted hyena*	
9	*Tera wa'ag*	*Vervet monkey*	
10	*Tselim hibey*	*Olive baboon*	
11	*Feako*	*Oribi*	

12	*Meadak*	*Common duike*	
13	*Teli bedu*	*Thomason Grant Gazelle*	
14	*Aner*	*Serval cat*	
15	*Nebri*	*Leopard*	*Endangered*
16	*Dikula*	*Common bush buck*	

Source: survey for EIA-2015

3.4 Socio-Economic profile the study area

The Socio-economic context of the study area has been studied by collecting and reviewing secondary data from the project tabias, Woreda sector offices and previous studies and primary data through on site observations and consulting of concerned officials. Detailed description of the socio-economic features of the study area is given in a separate Socio-economic Study Report. The descriptions given in this EIA Report focus only on the issues that is mostly relevant to the environment impact study.

3.4.1 Administrative conditions

The project is located in Kafta humera Woreda, moderately dense populated , the feasibility study states that project PCA includes four kebeles completely and two kebeles partially; which holds a total cultivated land of **155,352** out of which about 30,000 ha will be under the project development plan. Most part of the project reserve area pumping stations situated within the nearby two kebeles namely Adebay and Hilet kaka which is 20 km north east of humera town.

3.4.2 Population and Demographic dynamics

The latest official figures show that Kafta humera Woreda has a total population of some 115,580 of which 60226 male and 55354 female and 29324 households. The average family size is around 3.88 which is significantly less than the project area's average which is 5 Whereas the total population of the specific project area is estimated to be 54,724 and with some household size of 20,754.

Table 5. Population size of THIP Tabiyas

S#	Tabiyas	Population size			Average HH size	Remarks
		Male	Female	Total		
1	Adebay	14,876	11,355	26,231	2,605	The current population figure is derived from projecting the population senses of 2007
2	Bereket	5497	2748	5296	8245	
3	Central	5421	4579	10000	2150	
4	Hilet qokq	429	340	769	269	
5	May kadra	9674	9003	18677	5073	
6	Rawiyan	4033	3769	7802	1958	
Grand Total		**31,290**	**26,383**	**54,724**	**20,754**	

Source: survey for-EIA, CSA, 2007

3.4.3 Economic base of the project area and the Woreda

Based on the survey and observations carried out at the project area sites, the majority of the population in the Woreda and that of the project area too, is mainly dependent on agriculture which is a mixed supplemented by animal husbandry for their livelihood. This is characterized by small scale farming with, average farm sizes of 2-5 ha and extensive investment land holdings of some 20 ha to 5000 ha.

Thus, the predominant means of living for the population of Kafta Humera Woreda including the project area is mixed farming. It is estimated that about 85 % of the population of the Woreda earn its livelihood from mixed agriculture. It comprises investment and subsistence agriculture in which cash crop and subsistence crop production is predominant, and livestock husbandry is intimately integrated with crop production. Whereas the community of the project area earns its livelihood income mainly from mixed farming.

Crop farming: Crops produced are mainly high value crops like sesame and it also consist of some chief food crops like maize, sorghum and some supplementary fruits and vegetables like banana, tomato, potato and salad are typical income and food source of the study area as well as Woreda. Majority of the crop produced in the project area is manly based on rain-fed farming with some irrigation practices mainly around Tekeze, Rawiyan, Gytse and Ruwassa Rivers. The average irrigated

land holding at household level is about 0.55 ha as already assessed in some sample existing irrigation schemes within the command area.

Livestock raising: As elsewhere in the country and the region, all types of livestock that contribute most to crop production activities and food sources of the community are reared in the project area. Livestock is the main source of economy in the Woreda which include cattle, goats, sheep, and poultry, and camel, donkey and bee colonies.

Table 6: Animal population of project area

S#	Tabia	Cattle	Goat	Sheep	Hen	Donkey	Total	Remarks
1	Maykadra	5665	3830	8685	6605	1463	26248	The weighted orange color indicates the rank of animal population based on their size. The darker the highest and the lighter one, the smallest respectively.
2	Central	394	146	304	1033	102	1979	
3	Bereket	4955	1200	12770	3870	403	23198	
4	Rawyan	7955	1200	14770	6870	892	31687	
5	Adebay	10378	3532	15890	2300	2894	34994	
6	Hillot koka	360	743	468	832	204	2607	
Total		**29707**	**10651**	**52887**	**21510**	**5958**	**120713**	

Source: survey for EIA, 2015

Existing irrigation practices: The areas where irrigation is practiced in the study area is limited to some river belts of the Tekeze main river course from Adbay to Bereket which is pumping based gravity and alongside the seasonal Rawiyan river a partially funded government, some 10 meter deep wells include the larger irrigation scheme in the area. However due to lack of sufficient irrigation the decline in water volumes has affected the production and the sustainability of the activities. The project relies on gravity water supply to distribute the water to the projects‟ beneficially and who work on a rotational patterns to ensure that all farmers are well served by the water supplies. The irrigated crops include, tomatoes, onions, maize and French beans among others. The quality of crop management on the local farmers‟ plots is generally low due to low use of agrochemicals and organic manure.

The impact of Weeds, insects and diseases: According to the interviewed farmers and development agents, several weeds are growing in the study area. The main weed control practices in the study area

are hand-weeding (for both the rain fed and irrigated crops), intercrop cultivation (vegetables and maize) and using herbicide (2,4-D) on sorghum and maize .The weeding frequency for the rain fed crops is mostly 2-3 times. Unlike the rain fed crops the vegetables farming is weeded more frequently. Insect pests are among the most important constraints to crop production. These agents may cause significant yield loss at the field and in stores. The major regular insect pests prevalent in the study area and their control measures are shown in the next table. Chemicals applied to control the insect pests are diazinone, fentrotine and malathione.

Table 7: Major insect pests

Insect pests		Crops attacked	Control measures applied
Local name	**Common name**		
Kancha Feharie	Stalk borer	Sorghum	Chemicals
	African ball worm	Sorghum	Chemicals
Fanta	Grasshopper	Sesame and sorghum	Chemicals
Aleba saret	Web worm	Sesame	Chemicals
Qoratsi gundi	Cut worm	Onion	Chemicals
	Thrips	Onion	Chemicals
Tsaeda hamema	White fly	Tomato and citrus	Chemicals
Qotsli sersari	Leaf miner	Citrus	Chemicals
	African, American or Sudan boll worm	Cotton	Chemicals
Efel	Aphid	Tomato and cotton	Chemicals
	Jassid, Milli bug, Aphid & Semilipper	Cotton	Chemicals
Filho	Termites	Mango	Chemicals

Crop diseases are also other most important production constraints. Major diseases prevalent are smut (on sorghum), root rot (on pepper, tomato and sesame), bacterial blight (on sesame), early and late blight (on tomato and pepper), blossom end rot (on tomato), basal root rot (on tomato), anthracnose (on sorghum, mango and citrus) and sesame phyllody (on sesame).

Agrochemical utilization and environment concern: Though the existing inexpensive irrigation practice of the study area has low agro-chemical utilization history and contribution towards contamination to the natural environment and water bodies. It is obvious that such mega-irrigation project could probably expect to utilize massive and variety of agro-chemical inputs in the long run. Due

to this, the un managed leaching effect can affect the existing quality of downstream surface and sub-surface water bodies and some ground water sources which in return could affect the human and animal health and ecological balance of the area. Agro-chemicals are being used to kill unwanted pests and weeds on farms and fertilize the soil for crops. They may be collected by rain water runoff and carried into streams and lakes or dams if applied abundantly. Irrigation and drinking water supplies can be contaminated with pesticides and nitrates, a pollutant often derived from fertilizer run off. In relation to the upper stream effect of contamination on the reservoirs of water pollution is not likely typical concern to the project since its main source of irrigation water supplied through pumping from a clean river runoff the Tekeze river but to some extent a recognized and likely effect for sediment deposition of the pumping station and cumulative agro-chemical accumulation on the reservoir area and canals could affect the down users.

3.4.4 Market access

Marketing and its efficient infrastructure is a very crucial concern for a given social and economic chain of existing local and regional project sustainability. Due to this especially in the recent time the project area endowed with well-organized marketing system and infrastructure accordingly there are some structurally seated official marketing centers and places of different agricultural and industrial commodities sold and buy. The existing and potential huge investment in the area specially, that of Maykadra holds a strong economic and marketing place in the study area.

3.4.5 Education status and enrollment

The educational enrollment in the project Woreda shows that there are 42 elementary schools, 5 secondary and one preparatory schools and other one technical/vocational junior college in Humera town. Based on a recent data of the Woreda education office about 30,637 was attending their education.

3.4.6 Public health status and facilities

Based on a rapid health status assessment the scope and capacity of patient serving differ from Tabia to Tabia almost all the kebeles have currently obtained health service in side or their nearest district at 5-15 km far from their locality. Though, there is some progressive improvement comparing to previous poor health status and sanitation problem in the area still a number of tropical and water born and related diseases are affecting the living standard, life expectancy and working capacity of the community which can affect effectiveness. According to survey some official reports reviews the main health hazards in

the project area are vector borne tropical diseases especially malaria, water born and related and respiratory tract infections. The top ten causes of morbidity (illness) reported by the Woreda Health Offices in 2014-2015 are listed below (table 8).

Table 8: Existing Top Ten Diseases in Kafta Humera Woreda

No	To ten diseases	Number of patients by project Woreda
1	Malaria with p.falciparum	11753
2	Acute febril illness/AFI/	7563
3	Acute upper respiratory infection(ARI)	6665
4	Other or unspecified	6020
5	Malaria other than p.falciparum	5878
6	Malaria with species other than p.falciparum	4731
7	Diarrhea/non bloody/	4279
8	Pneumonia	3046
9	Helminthiasis	2484
10	Infection of skin & subcutaneous tissue	2259
Total		**54,678**

3.4.7.1Health Facilities

Health Centers are the focus facilities for curative and preventive health care in rural areas in Ethiopia. Each Centre is designed to meet the medical and health needs of a population of some 25,000 people. They are staffed by a Public Health Officer, nurses, community nurses, clinical nurses, environmental health workers and other paramedical staff.

Health facilities operating and serving the PCA population include four health centers, two health posts, and five clinics.

3.4.8 Domestic Water supply and use status

In the PCA most water for domestic uses is obtained from groundwater at depths vary from some 7 m shallow wells Rawiyan and Adebay to 150 m deep wells in Maykadra and Bereket Campaigns supported by Woreda and regional government have resulted in a significant density of protected wells with hand pumps which serve for domestic and animal drink are more utilizing in Rawiyan and Adebay. Thus a

total of 194 tap water sources exist in the Woreda, which include 41 hands dug wells, 116 shallow wells and 37 deep wells.

3.4.9 Road Access and transportation

The project area which has an average distances of 12 km from the zonal town Humera is 654k.m and 1437km far from Mekelle and Addis Ababa respectively. Most of the project Tabias found alongside two main roads namely Shire-Humera asphalt main road and Humera-Lugudi (Sudan). Thus Rawiyan, Adebay, Hiletkoka and Maykadra extend within 42km of asphalt roads while the two kebeles are reached by 17 gravel road. Additionally the PCA also get alternative road access via Gonder Humera Dansha. In relation to transport facility there is higher traffic flow and relatively good facility in the area with official bus terminals in humera town and Maykadra Generally speaking, the project area has a better road accessibility and transport facility owing to its location.

3.4.10 Housing and settlement pattern

The settlement housing pattern of the project area is situated in well organized in township and village districts. Three of the project kebeles namely Maykadra, Adebay, Rawiyan have a growing town structure which have centralized administration of municipality based. Majority of housing structure is built steel dominant wooden pillars and some concrete based buildings especially in the secondly ranked town of the Woreda i.e. Maykadra. Except some two kebeles that is central and Hiletkoka which has still rural village structure of settlement and housing pattern the rest four tabias of the project are in a progressive urbanization trend. Thus, all social services and economic and marketing exchange are directing in well centralized and easily accessible manner.

3.4.11 historic and Cultural heritage sites

According to a rapid environmental assessment (REA) no preserved prehistoric, historic and officially recognized cultural heritage site is found within the PCA. But some local worshiping places like church are found within the command area; typically churches in central and Rawiyan have situated directly in the intermediate part of the command. Due to this some effects related to canal crossing or other infrastructure building could rise.

3.4.12 Energy base

Different source and utilizing patterns of energy is available within the PCA. In most of the Woreda and kebeles centers especially at the main town Humera the electric city coverage is improved from recent

times and structurally it has a good management and infrastructure facility since it serves as technical and supply center of the district. Though electrification has is a recent history in the area which is officially reported to begin since 2004 E.C the coverage is progressive except some remotely seated off grid rural settlements majority of the Woreda recently have relatively fair status.

3.5 Stakeholder and Community Consultations

To assess the public and concerned officials view about the proposed irrigation project several structurally organized public hearing and stakeholder consultation phases was held during the project scoping phase of the EIA at three representative project areas viz. Hiletkoka and Rawiyan. The project consultation have received feedback from project area residents on a number of occasions and by various methods, ranging from informal meetings in the field through focus-group discussions to formal consultative public meetings and stakeholder consulting forum .

Although the residents are generally supportive of any project or changes that will lead to economic betterment and increased livelihood opportunities, especially roads and marketing facilities, they are, overwhelmingly, concerned about land tenure and future use right among the project area settlers. Locally, farmers have three recognized land use right private, house hold and investment land and different levels of soil fertility, from high to low, respectively. Farmers are fearful that the project could result in either an absolute loss of land, or land consolidation and thereby loss of access to some plot of land to the project infrastructure and re-distribution.

But still they raise some doubts to negotiation and clarification during the different consulting phases these can be shortly summarized as:

- When the project begins the loss of assets and inadequate or no compensation, displacement to make way for commercial farms or "investors".
- Having to change cropping patterns and systems, especially their local cash crop
- The changing and re-shaping of the usual grazing pattern.
- Lack of markets and marketing facilities
- Price drops due to over-production and inadequate markets.
- Lack of accessibility to ecologically tolerable irrigation crops

- The need to training and experience sharing from best practicing areas
- Special technical assistance to women and people with special need

After an open ended and full participation some wrong perceptions have be able to shaped to better argument and the perception of the community on this project were awfully positive. Generally speaking, most of the participants which is over 95% eagerly welcomed the proposed irrigation project to their locality and they strongly declared that any contribution expected from them including some local labor force, land and any expected effort from them could devotedly contributed until the final efficient implementation of the project.

CHAPTER IV: POLICY, LEGAL AND INSTITUTINAL FRAMEWORK

4.1. General Overview

This chapter outlines the policy, legal and institutional frameworks governing environmental issues in Ethiopia, reviews the African development Bank Integrated Safe Guard Systems, besides looks into applicable international conventions and or agreements.

4.2 Relevant national policies and strategies

4.2.1 Constitutional base

The Constitution of Ethiopia (August 1995) embodies the right of the Ethiopian people to development and to live in a clean and healthy environment. The Conservation Strategy of Ethiopia emphasizes the importance of incorporating environmental issues into development activities right at the initial stages of development. The Environmental Policy of Ethiopia (April 1997) aims to "improve and enhance the health and quality of life of all Ethiopians, to promote sustainable social and economic development through sound management and use of natural, human-made and cultural resources and their environment as a whole, so as to meet the needs of the present generation without compromising the ability of future generations to meet their own needs". It further seeks to ensure the empowerment and participation of the people and their organizations at all levels in environmental management activities, and to raise public awareness and promote understanding of the essential linkage between environment

and development. The Environmental Policy recognizes the need for environmental impact assessments and environmental audits in development projects.

A number of sectoral environmental policies have been, or are in the process of being, prepared or endorsed. These include policies relating to soil husbandry and sustainable agriculture; forest woodland and tree resources; genetic species and ecosystem biodiversity; water, energy and mineral resources; human settlement, urban environment and environmental health; pollution from industrial waste and hazardous materials; atmospheric pollution and climate change; and cultural and natural heritage.

4.2.2 Environmental Policy of Ethiopia

The Environmental Policy of Ethiopia (EPE) was issued in April 1997. The EPE supports Constitutional Rights through its guiding principles. The overall policy goal is to improve and enhance the health and quality of life of all Ethiopians, to promote sustainable social and economic development through sound management and use of natural, human-made and cultural resources and their environment as a whole, so as to meet the needs of the present generation without compromising the ability of future generations to meet their own needs. The policy seeks to ensure the empowerment and participation of the people and their organizations at all levels in environmental management activities, and to raise public awareness and promote understanding of the essential linkage between environment and development. In addition to its guiding principles, the policy provides sectoral and cross-sectoral environmental policies. Environmental Impact Assessment (EIA) policies are included in the cross-sectoral environmental policies. The EIA policies emphasis the early recognition of environmental issues in project planning, public participation, mitigation and environmental management, and capacity building at all levels of administration.

The policy establishes the Environmental Protection Authority (EPA) to harmonize Sectoral Development Plans and to implement an environmental management program for the Country. It also imparts political and popular support to the sustainable use of natural, human-made and cultural resources at the federal, regional, zonal, Woreda and community levels.

4.2.3 Land Tenure, Expropriation and Compensation Policies

The Constitution gives every person the ownership right for the property he has invested on the land, and in this regard article 40 (7) states that every Ethiopian shall have the full right to the immovable property he builds and to the permanent improvements he brings about on the land by his labor or capital. If the land that is owned by an individual is expropriated by the Government for public use, the person is entitled for compensation. In this regard, article 44 (2) of the Constitution states that all persons who have been displaced or whose livelihoods have been adversely affected as a result of state programs have the right to commensurate monetary or alternative means of compensation, including relocation with adequate state assistance.

4.2.4 Water Resource Policy

The Ministry of Water Resources formulated the Federal Water Resource Policy in 1998 for a comprehensive and integrated water resource management. The overall goal of the water resources policy is to enhance and promote all national efforts towards the efficient and optimum utilization of the available water resources for Socio-economic development on sustainable bases. The document includes policies to establish and institutionalize environment conservation and protection requirements as integral parts of water resources planning and project development.

4.2.5 Wildlife Policy

The Wildlife Policy was developed in 2006 by the Ministry of Agriculture and Rural Development. The prime objective of the policy is to create conducive environment for the preservation, development and sustainable utilization of Ethiopia‟s wildlife resources for social and economic development and for the integrity of the biosphere/biodiversity. It covers a wide range of policies and strategies relating, amongst others, to wildlife conservation and protected areas with four categories from the highest protection ranking *‘National Park’*, followed by *‘Game Reserve’* and *‘Sanctuary’* to *‘Controlled Hunting Area’*.

4.2.6 National Population Policy

This Policy was issued in April 1993 and aims at closing the gap between high population growth and low economic productivity through a planned reduction in population growth combined with an increase in economic returns. With specific reference to natural resources, the main objectives of National Population Policy are:

- Making population and economic growth compatible and the overexploitation of natural resources unnecessary;
- Ensuring spatially balanced population distribution patterns, with a view to maintaining environmental security and extending the scope of development activities;
- Improving productivity of agriculture and introducing off-farm/nonagricultural activities for the purpose of employment diversification;
- Maintaining and improving the carrying capacity of the environment by taking appropriate environmental protection and conservation measures.

4.2.7 Policy on Public Health

Ethiopia's health policy was issued in 1993, with the aim of giving special attention to women and children, to neglected regions and segments of the population, and to victims of manmade disasters. The priority areas of the policy are in the field of Information Education and Communication (IEC) of health to create awareness and behavioral change of the society towards health issues, emphasis on the control of communicable disease, epidemics, and on diseases that are related to malnutrition and poor living condition, promotion of occupational health and safety, the development of environmental health, rehabilitation of health infrastructures, appropriate health service management system, attention to traditional medicines, carrying out applied health research, provision of essential medicines, and expansion of frontline and middle level health professionals. The Government in its Plan for Accelerated and Sustained Development to End Poverty (PASDEP) document has reaffirmed its commitment to accelerate progress on maternal and child health and to reduce in child and maternal mortality rates by expanding the provision of essential health and nutrition services to the poor.

4.2.8 Ethiopia water Policies and Proclamations

Ethiopian Water Resources Management Policy is set out in Proclamation No. 197/2000 (the "WRM Proclamation"). The policy is intended to promote comprehensive and integrated water resources management and optimal utilization of available water resources for sustainable socioeconomic development. *Inter alia*, the policy calls for conservation and protection of water resources as an integral feature of the water resources planning and development process, and therefore mandatory EIAs of all water resource development projects (see Chapter 5 of the EPA's 2003 EIA Procedural Guidelines which cover water development for agriculture and hydropower, as well as associated resettlement). The

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

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

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

The Strategy is a comprehensive document, covering all aspects of water resources development and management. *Inter alia*, it calls for mandatory EIAs for all water projects, and promotes gender mainstreaming (see Section 3.3.12). From an environmental point of view, it is interesting that the Strategy includes a call to "Reclaim existing wetlands" by drainage and other means, but not for their conservation or the protection of wetland values. MoWE sub-sectoral policies include Irrigation, Hydropower, and Water Supply and Sanitation, each with an associated Strategy. In 2002 MoWR published the *Water Sector Development Program* (WSDP) covering the period 2002- 2016 (MoWR 2002). This defines concrete interventions in terms of projects and programmes to achieve the water policy objectives, using the guidelines set under the National Water Strategy. The WSDP is a development program with a 15 year planning period from 2002-2016, divided into three five year development programs:

4.2.9 National and Regional Conservation Strategies

The major environmental and natural resources management issues facing Ethiopia are well documented in the Conservation Strategy of Ethiopia (FDRE, 1997). The CSE sets out detailed strategies and action plans as well as the institutional arrangements required for the implementation of sectoral as well as cross-sectoral interventions for the management of Ethiopia's natural, man-made and cultural resources.

The CSE provides a strategic framework detailing principles, guidelines and strategies for the effective management of the environment.

The most important areas that are considered in the document include the following:

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

Implementation of the CSE required the formulation of region-specific conservation strategies in line with Federal environmental policy, which was approved in 1997.

Since the early 1990s, the Federal government of Ethiopia has undertaken a number of Initiatives to develop regional, national and Sector strategies for the environmental conservation and protection. Paramount amongst these was conservation strategy of Ethiopia (CSA, 1996). It provided a strategic framework for integrating environmental planning into new and existing policies, programs and projects. It is an important policy document, which views environmental management as part of the economic development. In particular, it recognizes the importance of incorporating environmental factors into development activities from the outset, so that planners may take into account environmental protection as an essential component of economic, social and cultural development.

4.3 Environmental laws and legislations

Based on the environmental protection policies, conservation strategies, the constitution and other adopted international conventions, the country has published a number of Proclamations and guidelines. Among which the following has cited in this EIA study according to their relevance.

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

The Constitution is the supreme law of the country all other policies, regulations and institutional frameworks must comply with. The Constitution states that People have the right to full consultation and expression of views in the planning and implementation of environment policies and projects which affect them directly or indirectly. The concepts of sustainable development and environmental rights are enshrined in the Constitution of the FDRE. Article 44 of the Constitution of the FDRE states that all persons who have been displaced or whose livelihood has been affected because of state programs have the right to commensurate monetary or alternative means of compensation, including relocation with adequate state assistance. However, the compensation does not take into account the value of land.

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

This Proclamation aims primarily at making the EIA mandatory for categories of projects specified under a directive issued by the EPA. The law specifies the projects and activities that will require an environmental impact assessment (EIA). The proponent of the project must prepare the EIA following the format specified in the legislation. The EPA will then review the EIA and either approve (with or without conditions) or reject it. Under this legislation, the EPA has to prepare procedures, regulations, guidelines and standards for the EIA.

4.3.3 Environmental Pollution Control Proclamation (Proc. No. 300/2002)

This is based on the right of each citizen to have a healthy environment and the obligation to protect the environment with a primary objective to provide the basis for developing environmental standards and the "polluter pays" principle becomes applied to all persons. IT empowers the EPA with a mandate of creating Environmental Inspectors with the authority to ensure implementation and enforcement of environmental standards.

4.3.4 Ethiopian Water Resources Management Proclamation (No. 197/2000).

This Proclamation was issued in March 2000 and has provisions for water resources management, protection and utilization to ensure that water resources of the country are protected and utilized for the highest social and economic benefits. The Proclamation defines the ownership of water resources,

powers and duties of the supervising body, inventory of water resources and registry of actions, permits and professional licenses, fees and water charges. According to the Proclamation, all water resources of the country are the common property of the Ethiopian people and the State.

4.3.5 Wildlife Conservation and Development Proclamation (No. 541/2007)

This Proclamation came into effect in August 2007 and its major objectives are to conserve, manage, develop and properly utilize the wildlife resources of Ethiopia; to create conditions necessary for discharging government obligations assumed under treaties regarding the conservation, development and utilization of wildlife; and to promote wildlife-based tourism and to encourage private investment.

4.3.6 Forests Conservation, Development and Utilization (Proclamation No. 542/2007)

Issued in September 2007, provides for the development, conservation and sustainable utilization of forests in satisfying the needs of the society. The Proclamation categorizes types of forest ownership as private forest and state forest. The Proclamation then goes on to give some specific direction for the development and utilization of private and state forests. It contains provisions for the Promotion of the Utilization of Private Forest.

4.3.7 Proclamation on Rural Land Administration and Use (Proc. No. 456/2005)

The objective of the Proclamation is to conserve and develop natural resources in rural areas by promoting sustainable land use practices. In order to encourage farmers and pastoralists to implement measures to guard against soil erosion, the Proclamation introduces a Rural Land Holding Certificate, which provides a level of security of tenure. According to the Proclamation where land, which has already been registered, is to be acquired for public works, compensation commensurate with the improvements made to the land shall be paid to the land use holder or substitute land shall be offered.

4.3.8 Research and Conservation of Cultural Heritage (Proclamation No. 209/2000)

It provides legal framework for Research and Conservation of Cultural Heritage and established the Authority for Research and Conservation of Cultural Heritage (ARCCH) as a government institution with a juridical personality. In addition, it has provisions for management, exploration, discovery and study of cultural heritage and miscellaneous provisions.

4.3.9 Water Users Associations

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

The WRM Proclamation is framework legislation, requiring elaboration by means of regulations and directives. Some regulations have already been adopted pursuant to Article 27 of the WRM Proclamation.

4.3.10 Environmental Guidelines

The GoE, mainly through the EPA, has published a number of guidelines for the EIA process. These cover EIA procedures in general, the review of EIA documents, and specific sectors: including that of irrigation.

4.4 Institutional Framework

4.4.1 Government administrative structure

The Federal Democratic Republic of Ethiopia is administered through a hierarchical system as follows: Regions (National Regional States), Zones (sub Regions), Woredas (similar to districts) and Kebeles (similar to parishes). The powers of regional governments include establishment of a State administration that advances self-government, protection of the Federal Constitution, enactment of the State constitutions and subordinate laws; formulation and execution of economic, social and development policies, strategies and plans of the State; administration of land and other natural resources in accordance with Federal laws. The zone, Woreda and Kebele deals with local administration within their respective jurisdictions.

4.4.2 Institutional framework (The federal EPA)

In 1995, the EPA was created by means of the Environmental Protection Authority Establishment Proclamation (Proclamation No. 9/1995). At the same time, an Environmental Protection Council (EPC) was established, with representatives from most of the federal ministries to supervise the EPA‟s

activities. The Director-General of the EPA was to serve as the Secretary to the Council and the EPA took on the duties previously assigned to the Ministry of Natural Resources Development and Environmental Protection (MoNREP). The mandate and duties of the EPA were subsequently clarified in the Establishment of Environmental Protection Organs Proclamation (Proclamation No. 295/2002). The federal EPA is responsible for:

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

4.5 African Development Bank Integrated Safeguard System

The AfDB adopted the Integrated Safeguard System (ISS) as a tool for identifying risks, reducing development costs and improving project sustainability. The ISS promotes best practices in these areas but also encourages greater transparency and accountability and protects the most vulnerable communities. The bank has now adopted five Operating Safeguards (OSs) to achieve the goals and the optimal functioning of the Integrated Safeguards System (ISS). These OSs are:

- **Operation Safeguard 1**: Environmental and Social Assessment: this is an overarching safeguard of determining a projects environmental and social category and the resulting environmental and social assessment requirements.
- **Operational Safeguard 2:** Resettlement land acquisition, population displacement and compensation: this consolidates policy commitments and requirements contained in the Bank's policy on involuntary resettlement, and incorporates a number of refinements designed to improve the operational effectiveness of those requirements.
- **Operational Safeguard 3**: Biodiversity and ecosystem services: this seeks to conserve biological diversity and promote the sustainable use of natural resources with a focus on integrated water resources management in operational requirements.
- **Operational Safeguard 4**: Pollution prevention and control, hazardous materials and resource efficiency: this covers the range of key impacts of pollution, waste, and hazardous materials for which there are agreed international conventions, as well as comprehensive industry-specific and regional, including greenhouse gas accounting. The Bank's new screening tool for climate change risk helps in screening and categorising a project in terms of its vulnerability to the risks of climate change.
- **Operational Safeguard 5**: Labour conditions, health and safety: this relates to workers conditions, rights and protection from abuse or exploitation.

The IAIP support program has been assigned a category 1 by the African Development Bank in line with the guidelines within the bank's ISS because the cumulative potential environmental and social impacts associated with the construction and operation phase of the works which the Bank intends providing funding for, could be significant and irreversible. Furthermore some of the project works (provision of access roads and installation of water supply pipelines) could potentially result in the displacement of farmers and their livelihood support farm lands.

Table 9: Africa Development Bank Applicable Operational Safeguard Policies

Operational Safeguard	Triggered?	Explanation
OS 1: Environmental and Social Assessment	Yes	The Project will finance a variety of activities that will consist of infrastructures including construction of pump stations, ponds, link access roads, installation of irrigation channels and supply mains to connect the pump station, ponds and farming areas. The cumulative environmental and social risks associated with these kinds of project are significant. It is therefore possible that the project may fall into Category 1.Thus ESIAs and Environmental Management Plans (EMP) has been prepared.
OS 2: Involuntary resettlement land acquisition, population displacement and compensation:	Yes	Field assessment observations on the site for the irrigation project indicated that the site is sparsely inhabited by settlers with most settlements organized into small towns. The project area has abundant vast plain irrigable land which provides enormous opportunity for carrying realignment of infrastructures at design stage to minimize resettlement of farmers or their properties. Thus there is high probability that no major resettlement will occur as a result of project activities. In the event few resettlement actions become necessary, compensation program is to be carried to free the sites and right of ways from its current occupants or farmers.
OS 3: Biodiversity, renewable resources and ecosystem services:	No	Tekeze irrigation system main components do not involve construction of large scale structures like irrigation Dam near or inside the Kafta Humera National Park. There is excess cultivated land (155,000ha) outside the National Park and the 30,000ha command area needed for irrigation can be easily met without encroaching the National Park. Thus the Surface pump based irrigation system is less likely to significantly affect the biodiversity, natural or critical habitats.
OS 4: Pollution prevention and control, hazardous materials and resource efficiency:	Yes	The residual impacts of the Tekeze Humera Irrigation project components to be supported by the ADB may have the potential to affect the environment and human health if that do not meet applicable environmental standards during construction and operations.
OS 5: Labour conditions, health and safety	Yes	The construction and operational phases of the project will involve the recruitment of temporary and permanent labor and staff members. Thus observance of health and safety aspects will become essential.

Operational Safeguards (OS) 1 on Environmental Assessment have been triggered because the project activities have the potential to generate significant environmental and social impacts to identified receptors within its area of influence. Operational Safeguard (OS2) has also been triggered because it

could displace households and farmers from their settlements and farmlands. Operational Safeguard (OS 3) has not been triggered due to the fact that the Tekeze irrigation system main components do not involve construction of large scale structures like irrigation Dam near or inside the Kafta Humera National Park. There is excess cultivated land (155,000ha) outside the National Park and the 30,000ha command area needed for irrigation can be easily met without encroaching the National Park. Thus the Surface pump based irrigation system is less likely to significantly affect the biodiversity, natural or critical habitats. Operational Safeguard (OS 4) on Pollution Prevention and Hazardous Substances is triggered since construction and operation will involve use and disposal of different types of wastes. Operational Safeguard (OS 5) on Labour, Working Conditions, Occupational Health and Safety is applicable since the construction and operation phases will involve a significant number of construction and operation workers.

4.6 International Environmental Agreements

Ethiopia has ratified many international conventions on natural resources and the environmental the relevant ones to this study include

- Convention on International Trade in Endangered Species (CITES
- Framework Convention on Climate Change (UNFCC
- Convention on Biological Diversity (CBD
- The UN Convention to Combat Desertification (UNCCD):
- The Cartagena Protocol on Bio-Safety to the Convention on Biological Diversity:
- Convention Concerning the Protection of the World Cultural and Natural Heritage (World Heritage Convention
- Convention for the Safeguarding of the Intangible Cultural Heritage (UNESCO
- International Treaty on Plant Genetic Resources for Food and Agriculture.
- Convention on the Control of Trans boundary Movements of Hazardous Wastes and their disposal (Basel Convention
- Stockholm Convention on Persistent Organic Pollutants (Stockholm Convention on POPs):
- Convention on the Conservation of Migratory Species of Wild Animals (CMS, Bonn Convention):

CHAPTER V: PROJECT ALTERNATIVES

5.1 Background

This study considered possible project alternatives which include alternative sites, activities, products, materials, technology and waste management procedures among others. The project report seeks to give a detailed description of the project area, technology, resources and other inputs that are to be put in place so as to promote the best working models that could be adopted to prevent injurious activities to the supporting resources.

5.2 No Action scenarios

This alternative implies the project does not proceed thereby enhancing the status quo. The status of the environmental resources neither improves nor worsens since the state of the resources is not interfered with at all. The „No Action" has various negative and possibly long term impacts to the area. Some of its consequences include:-

- Increased water losses and wastage in the existing irrigation schemes thereby bringing about water scarcity
- Loss in productivity of the land
- Increase deforestation and land degradation for additional land seeking
- Reduce animal husbandry efficiency
- Reduce employment opportunities and aggravate un employment
- No generation of capital or no prosperity

5.3 Alternative Irrigation Methods

There are several irrigation methods that can be used in the project area, from the most appropriate method has to be chosen that promote effectiveness in the water conservation measures. There was a consideration of various methods that would be used in the areas so as to ensure water conservation measures are promoted. Some of the methods considered are sprinkler Irrigation, Flood Irrigation, drip irrigation and surface irrigation and the latter in which water flows to the land by gravity has been selected due its convenience to the area under consideration.

5.4 Alternative Design and layout

This project can be considered to be more or less site specific. From the initial feasibility study report for the intake of the proposed canals, the intake sites are appropriate as they are located on higher levels from the land to be irrigated. Some of the factors that influenced the choice of the locations include the agro-climatic conditions of the area, the soils, water availability and the drainage system in the areas. These can be seen to be the most appropriate site locations for the activities because of close proximity to the sources of water to be used for these activities and for the convenience of the water sustainability and regeneration. A number of alternative designs and layouts have been considered in the design process. The major options include:

5.4.1 Irrigation technology

Soil and water conditions in the PCA are difficult. In most of the area, especially in the southern parts it will be extremely important to minimize water applications so as to guard against the risk of groundwater leaching effect and secondary Stalinization. Pressurized irrigation is an excellent technique for managing water efficiently, but requires higher levels of investment than surface irrigation (for pumps, pipes and sprinklers), has higher running costs (more complex technology) and higher skills requirements for operation and water scheduling. The risks to soil quality will be minimized (a) by excluding sensitive areas, (b) by prioritizing drainage, and (c) by monitoring groundwater and soil quality. Nevertheless, with surface irrigation project benefits may drop with time because of the development of water logging and salinity.

5.4.2 Flood management alternatives:

At present the command area is highly affected by poor drainage pattern and higher flooding. To greater extent majority of the command area has exposed to soil water logging effect every year. This maintains soil fertility and allows flood recession but also destroys crops and prevents access for sustainable and effective project implementation.

5.4.3 Command area layout

The command area layout is determined by gravity for both irrigation and drainage, and consequently has many choices. One consideration is the inclusion or exclusion of existing settlements in the system of channelization including urban peripheries planned for future expansion.

5.4.4 Road layout

The road layout is based on principal service roads along the main and secondary canals. Within the scheme subsidiary roads run mainly north-south. This choice reflects both the landscape, which basically drains from north to south have economic and administrative links, which are to the market and on the main north-south road which crosses most of the project kebeles.

5.4.5 Pump station establishment

The detail Tekeze-humera surface irrigation project design have fixed six (6) pump station sites around heilegen which is about 15 km north-east of humera town though most of the fixed stations are feasible in terms of technical, geological stability and to some extent environmental aspect.

5.5 The Alternative operating system

An effective operating system could possibly increase the efficiency of the project and un doubtable helpful to achieve the expected ultimate goal. Alternative operating systems that should consider during the design process may include 24-hour irrigation halves the flows needed to a particular location and therefore reduces investment costs for channels, but farmers have to be available at appropriate times including in darkness. It was considered unrealistic to expect efficient 24-hour irrigation under the conditions of the project area. The alternative is to double the size of the main canal, with associated costs.Various rotation periods were analyzed (the length of time between watering). The recommendation for a fixed rotation could make on the basis of fairness, so that no farmers would have to water more than the reasonably fixed conventional schedule. Even to wide approach this can help to regulate the excess soil water logging effect and some disputes emanating from lack of local management in experience and unfair irrigation water utilization.

5.6 Alternative management systems

Based on the nature of the project, administrative structure, cultural tie of the community and geographical location and settlement pattern of the project beneficiaries different approaches of management alternatives could be proposed to this project. Accordingly, the on-farm and off-farm management structure could effectively well adapt to this project. By considering the social settings and administrative base and to some extent geographical factors the on-farm approach could be effectively applicable and strongly recommended.

CHAPTER VI: IMPACT ANALYSIS AND MITIGATION MEASURES

This chapter presents the assessment of environmental impacts likely to arise as a result of implementing the proposed irrigation project. Each issue has been dealt based on its nature, predicted impact, extent, duration, intensity and probability and the stakeholders and/or values affected. Although impacts has been analyzed and quantified as much as possible, many of the impacts of the THIP will be indirect. In such cases, and to indicate significances a qualitative assessment has been used and value judgments are part of the study which are experience based opinions. As in most impact studies, the analyses focus on potential problems and their solutions rather than on the project's overall benefits. However, where opportunities for enhancement occur these are identified and outlined. The analysis is divided into two main sections: the Construction Phase and the Operation Phase.

6.1 Background

Irrigation has contributed significantly to poverty alleviation, food security, and improving the quality of life for rural populations. However, the sustainability of irrigated agriculture is being questioned, both economically and environmentally. The increased dependence on irrigation has not been without its negative environmental effects. Inadequate attention to factors other than the technical engineering and projected economic implications of large-scale irrigation or drainage schemes in Africa has all too frequently led to great difficulties. Decisions to embark on these costly projects have often been made in the absence of sound objective assessments of their environmental and social implications.

It is essential that irrigation projects be planned and managed in the context of overall river basin and regional development plans, including both the upland catchment areas and the catchment areas downstream. According to the initial environmental evaluation during the scoping phase each actual and potential adverse impact that emanate as a result of this project has been identified and prioritized based on their significance, nature, magnitude, reversibility and scope of coverage.

6.2 Identification of Impacts

The anticipated impacts have been predicted and evaluated using standard methods of impacts identification. Several approaches to impacts identification were used such as screening and REA checklists and matrices to identify the main sources for potential impacts from the proposed activities. Public consultations also played a key role in the process as the local communities are the people who have experienced and devised means to address these impacts.

Irrigation projects have the potential to generate a wide range of both positive and negative physical, biological and social changes with possible consequences to communities and the environment ranging from onsite to neighboring areas. Based on the detailed EIA study of this proposed irrigation project the likely impacts that are expected to occur could be grouped into,

- Positive or negative impacts
- Direct or indirect impacts
- Long-term or short term in occurrence
- local and downstream effects

The proposed project induces both positive and negative impacts with cumulative nature in some cases. Both potential positive and negative impacts are predicted to arise during construction and operation phases and measures should be taken to manage or avoid the negative ones.

6.2.1 Positive Impacts

Induction of the proposed surface (pumping) irrigation project to the area is expected to bring a variety of positive socio-economic and environmental impacts. Thus, the major potential positive impacts can briefly summarize as:

Enhance agricultural productivity, food security and reduce poverty: New development of such large project on this previously un utilized arable land with sufficient water source would boost the agricultural productivity of the area and this in turn help to achieve food security. The proposed development project is meant to bring about land productivity and over economic property through integrated agriculture and agro - industry including livestock development.

Creation of Job opportunities: Implementation of the project will generate job opportunities for both skilled and semiskilled as well as labor in general and for the local population in particular. After the completion of the irrigation structure, it is expected that the land will be certified for the existing individual owners and extra land will be re allocated to landless members of the community who will engage more farmers and create job opportunities.

Increase efficient use of water resource of the area: Efficient use of water resources is crucial for the development of country's socio-economic development; hence expansion of the proposed irrigation project will enable to use available Tekeze River water resource efficiently and effectively through pumping irrigation, which otherwise flow freely for years.

Efficient use of land resources: The current use of the proposed land is partly grazing and partly under rain fed agriculture, thus developing it into irrigated farm would provide better production and efficient use of the land bringing an overall economic improvement at local and national levels.

Improved Infrastructure: The expansion of the access roads into the villages will ultimately lead to opening up to the markets. There have been many challenges that arise out of the undeveloped roads especially in transportation of farm products during the rainy seasons and now with the opening up of these areas, accessibility shall be made easy. Consequently, the improved revenue growth will precipitate the development of other social amenities.

Gender encouragement and benefits: Like other community members, both women and men will benefit from the agricultural transformation and employment opportunities of the project equally. Furthermore, women will be more benefited by running shops, bars and petty trades in the project area during the construction and operational periods. As a result, more women will likely be engaged in income-generating activities by selling local products and services to the workers. After the completion

of the project, more and more agricultural and non-agricultural income generating opportunities will be created for women.

Table 10: Summary of Positive Impacts of the proposed irrigation project during Operation phase

I	Planned
	Increased cropping intensity on some 30,000 ha due to the provision of dry season irrigation water
	Increased crop yields due to improved drainage, inputs and crop husbandry
	Increased crop diversity due to an improvement of land capability by irrigation and drainage and
	improved access to seeds and markets
	Improved livestock husbandry and productivity
	Increased and stabilized household incomes from agriculture for some 10,00 farm households
	Increased secondary economic activities - agriculturally-related goods and services - and associated local
	employment, including for scheme operation and maintenance
	Improved institutional capacity of government organizations responsible for water management and
	agricultural development at regional, woreda and kebele levels
	Improved road access, with many associated benefits
	Social development, particularly due to the establishment and operation of democratic, gender-sensitive
	and transparent water management organizations at different levels
	Reduced impact of flooding
II	**Anticipated positive impacts**
	Improved adult literacy in command area due to adult literacy programs
	Improved health for command area households due to multiple health initiatives, combined with
	Improved literacy, women's status, road access and household incomes
	Improved status and quality of life of women in the command area due to multiple community
	Development initiatives especially provision of domestic water supplies, increased household incomes,
	Adult literacy, improved health, better access to fuel and inclusion in community decision making
	Mechanisms
	Conservation of fish and wildlife in command area and associated rivers due to establishment of habitat
	protection and fishery management mechanisms and increased environmental awareness
	Reservoir fishery
	Restoration of wetland ecosystem functions adjacent to command area due to wetland restoration program

6.2.2 Negative impacts of the project

Both biophysical and social negative impacts and their possible mitigation measures are compiled in this part of the document which are either quantified or qualitatively described in terms of significance or value judgments based on professional experience opinion. The analyses focus on potential problems and their solutions rather than on the project's overall benefits, dealing in both construction and operation Phases. It should be noted that measures to many of the issues discussed need to be implemented in Pre-construction Phase. Poor water quality below an irrigation project may render the water unfit for other users, harm aquatic species, aquatic weed growth. Reducing the river flow changes flood plain land use and ecology and can cause salt water intrusion in the river and into the groundwater of adjacent lands.

Impacts on endangered species and vegetation: Increase clearing of vegetation will be immediately noticed impact so as to lay canals for water conveyance resulting in loss of biodiversity. Most of the wild animals that used to inhabit in the area had moved to less disturbed areas elsewhere like Kafta-Sheraro National Park areas along the Tekeze River adjacent to the project area, those species like Anubis baboon, Vervet monkeys and hyenas and which still found within the command area will further migrate due to this project.

Loss of Land and Displacements: The average land size within the project area was found to be between 2 to 5 ha per household. The individual land owners may be affected through land repossessions to pave way for canal laying. The initial assessment established that 325 landowners are likely to be affected by the proposed activities.

Impact on Soil Erosion and degradation: An increase in the soil erosion due to construction activities that involves excavation and vegetation clearing is predicted. Some of the loose soils accumulated in the area will be swept away by winds and rainwater leading to siltation which is detrimental to the aquatic life.

Soil Compaction: The high traffic especially of machineries and the construction workforce within the project area is likely to lead to compaction of the soil structure further leading to reduced capacity of the water to infiltrate into the soil thereby affecting the soil-water balance and the hydrological cycle

largely. Adverse soil modification usually occurs in irrigation schemes mainly due to the low efficiency of irrigation systems.

Impacts of Inappropriate Reservoir Management: Improper reservoir management could result in inadequate water released for daily command area demands; excessive water released resulting in inadequate supplies to meet full dry season demands, thermal stratification, inadequate or no environmental flow releases, insufficient detention of flood flows, and excessive releases with inadequate warning to downstream residents, some infrastructure in the command and even the project's infrastructure could easily affected for these reasons.

Pollution of Rivers and Wetlands: The construction of the intake canals and water conveyance systems if not well controlled could deposit resultant construction wastes such as sediments from the earthworks, oils and fuels into the rivers and also through surface run offs. This may ultimately lead to potential degradation of the water quality especially for downstream users and adversely affect the aquatic life.

Increased Traffic: There is meant to be an increased traffic flow into the project area varying from heavy to light and fast vehicles for the movement of the construction materials. The access roads largely made of earthen roads could result in increased dust and consequent increased traffic especially at the daily onset and offset of the construction works. This is likely to affect the health of the residents and the aesthetic value of the areas.

Extraction of Construction Materials: There is a heavy demand for construction materials in bulk such as sand, gravel and rocks. These will be extracted from the local sources. The extraction and transport of these materials is likely to result in the distortion of the ground structure, vegetation loss, dust emission, oil spills, noise and potential for accidents. Further, the quarries and borrow pits associated with extraction of raw materials may collect water which will form ponds. Such stagnant water is highly suitable breeding grounds for mosquitoes and other diseases vectors.

Construction Wastes: The construction activities will ultimately lead to the production of solid wastes primarily the soil excavated and rock debris, metal cut offs plastics, cardboards, paper, wood and waste concrete among several others. The effects of improperly managed wastes could be far reaching and

may include aspects of environmental pollution, nuisance to the local communities, and increased vermin among other undesirable effects. During the construction phase liquid wastes including grey and black water, concrete washing and canal watering, run off from workshop areas are likely to cause imminent threats to surface and groundwater.

Pollution; Dust and Air Quality Concerns: The construction activities mostly the excavation of the canal will generate a significant amount of dust which may be blown by the wind and construction vehicles. This is likely to affect the workers and the residents of the project area and its environs. Construction vehicles and other plant on site may generate a lot of smoke from the diesel engines leading to air pollution. Noise pollution emanating from construction machinery and vehicles will impact livestock and wild animals.

Impacts on climate change\ greenhouse effect: Climate change the cumulative effect of combined emissions of three major Green House Gases (GHGs)namely carbon dioxide, methane, and nitrous oxide to the atmosphere over many years, is directly or indirectly attributed to human activities and increase the global warming. Greenhouse gas emissions from irrigation development could conceivably be generated from two sources when water is released and applied to the fields, there may be a change in cultural practices, as well as in the enterprise mix on the farm. These changes could significantly alter the production mix, input demand for factors of production, and may lead to increased emissions of GHGs. Major Sources of such emissions include the application of fertilizers, pesticides and manure to crops, the decomposition of crop residues, production of legume crops leading to fixing of nitrogen in the soil, and soil carbon sequestration through tillage practices. In addition to direct emissions, irrigated production may lead to some indirect and induced emissions related to the technology of production applied to various crops and lead to emissions. Climate change is sensible in the area since the arid and semi- arid climate with aggravation of the expansion of Sahara desert and local desertification, in recent years a clearly visible climate change effect can be seen in the long term.

Poor Construction Techniques: The construction of the main intake, laying pipe works, canals construction must be done appropriately and to the recommended engineering designs. Inappropriate construction techniques will lead to poor water regulation, intensive manual labor use and eventually conflicts in the water intake.

Water Quality Degradation: The quality of the water is within the permissible limits as provided in the Environment Management (Water Quality) Regulations. However, intensified use of pesticides and fertilizers can lead to ground water pollution and the Eutrophication of the water bodies thereby polluting the water bodies. The disposal of containers used to pack agrochemicals if not properly disposed can also find their way into nearby water bodies, leading to pollution and probable poisoning of the aquatic life.

Water logging, soil salinization and sedimentation: Inappropriate management of the water like excess irrigation and inadequate drainage will lead to water logging and leaching of water soluble nutrients to levels where they are no longer available for use by plants. Waterlogged conditions will adversely affect growth of plants including crops and may also encourage change in natural composition of vegetation by suppressing some and encouraging others. Cultivation along the river banks may lead to the loss of the riparian ecosystems thereby leading to a vulnerability of the soils surrounding the rivers and thereby leading to collapse and eventual sedimentation into the rivers.

Extended Exposure to Malaria: Malaria is endemic in the area and a major cause of disease and death. The project is likely to change the pattern of malaria infections during the year, with an extension into the dry season. Permanent (year-round) malaria is less dangerous than short, intense seasonal transmission, but malaria will continue to have a very high impact on human health, especially for children.

Pests and Crop Diseases: Increased acreage of irrigated land may create a more conducive environment that is favorable for the increase of agricultural pests and plant diseases. Change to a more uniform environment on the project areas will favor vigorous species adapted to a wide variety of conditions. Diseases and weeds may spread quickly via the re-use of waste-water and drainage water or by the application of fertilizers. Increase in pests and plant diseases may affect the farm harvest thereby leading to food insecurity. Increased pests and crop diseases will trigger increased use of pesticides leading to water contamination and the degradation of resources.

Impact on water quality for fish: Water quality for fish may be lowered due to increased salinity and the use of agrochemicals, besides the project will affect water quality by augmenting normal dry season and wet season flows with drainage flows from fields. These return flows will carry any chemicals

added to the fields and not immobilized, biodegraded or taken up by plants, including pesticides, fertilizers and salts.

Impacts on existing infrastructure and future urban land use: An estimated land area of about 30,000 ha will be irrigable under this project which mainly covers land surrounding semi-urban peripheries of different towns in the Kafta humera Woreda, which is congested by different current infrastructures and future development plans of roads, water supply, urban expansions. So due to the building of the project infrastructure like reservoir, canals and other similar schemes it would put pressure on the available infrastructures and future development plans if mitigation measures are not early applied.

Impacts on Livestock Husbandry System: The project will reduce the total area of grazing and increase the demand for labor with knock-on effects on livestock numbers. Livestock, especially cattle, are essential for the existing mixed farming system and provide many practical services. The project will reduce the area available for grazing due to direct land taken for the infrastructure. The consequences of reduced grazing land and exclusion from seasonal fallow or use of post harvest fields for livestock herding because of which livestock will be more tightly controlled and will survive on even fewer grazing resources besides labor demand for herding will increase.

Figure 5: Animal population pressure within the command area

Source: field survey for EIA

6.3. Downstream Effects

Though the current water balance and river flow do not indicate any downstream effect both on the ecological function of the river and downstream users, it should early consider during the design phase of the project since future water use scenarios could be changed.

6.3.1 Environmental Flows

Environmental flows are the water that is left in a river, or released into it (e.g., from a reservoir), in order to maintain features of the ecosystem. In recent years there has been proliferation of methods for estimating environmental flows, ranging from relatively simple low-confidence desktop approaches to resource intensive high confidence approaches. The more comprehensive methods are based on detailed multidisciplinary studies often involving expert discussions and collection of large amounts of geomorphologic and ecological data. Typically they take many months sometimes years to complete.

Tekeze River served as the core ecological base both for the neighbor forest, wetland-ecosystem, birds and aquatic species like crocodile and fish. Though recently the stream flow indicates an adequate release to downstream, it may shrink through time due to over exploitation or climate change incident. Therefore, to guaranty the stream sustainable ecological function, 20% of the upper stream flow from the project intake site should be timely planned and monitored during river water utilization.

6.3.2 Water balance scenarios of Tekeze River

Constructions of the Tekeze hydro-electric power dam and upstream water resources development have altered the Tekeze river natural water balance. Therefore, it is important to get a baseline picture of the river behavior, taking into account the main recent water resources development and being a control sample for the scenarios to come. According to many hydrological studies, the mean flow of the Tekeze River at the frontier between Ethiopia and Sudan is around 20,000 Mm3/year. Based on the baseline scenario consists of application of the observed hydrology of the previous five years, Tekeze river is dramatically increased by 0.5-1m height, which is adopted from long experience resident farmers scenario that shows the upstream is positively affected to reach the river its pick flow even in very dry and drought season.

6.3.3 Impacts on downstream users

Though hydro-meteorological data shows the water balance and stream flow of the river dramatically increased in the previous five years, mainly because of the upper stream dam (Tekeze-hydro power arc dam), adequate water release for such extensive irrigation system will put another new pressure on downstream users paired with the future climate variability and changes. At a distance of some 5-8 kms down to the proposed intake site, existing irrigation practices with an irrigable land of some 102 hectare is currently growing by local farmers and investors. This figure of irrigated land will be expected to show progress in the near future, therefore, while estimating net irrigation water demand considering and monitoring the release to downstream users must be well planned.

6.3.4 Water Regulating and Monitoring System

Knowledge of water resources and their uses is an important basic function, essential to implement other functions. Other than budget related staff and equipment shortages, separation of tasks (data collection and data processing including quality data control) is one of the main difficulties.

CHAPTER VII. PROPOSED MITIGATION MEASURES

7.1 Construction phase

7.1.1 Land required temporary for contractors camps

The contractor will require land to establish camps including site offices, workshops, stores, vehicle parking, and staff accommodation. Other land will be needed temporarily for aggregate processing and concrete manufacturing, metal fabrication, back-up power generation, and access.

Mitigation options:

- ✓ Allocate land with possibly lowest value for the contractor camp
- ✓ Establish a mandatory entitlement related to temporary land
- ✓ Apply best practice management in terms in contractor camp management
- ✓ Demand the contractor to employ a fulltime community relations officer to establish a formal Social Responsibility system.
- ✓ The contractor's facilities should be completely removed before the end of the contract, unless required by the Employer, and the land restored to its previous condition or better.

7.1.2 Impacts of Construction Access & Traffic

The contractor needs to access the site using permanent and temporary roads which may existing or newly constructed ones. Similarly light and heavy construction traffic will use both public roads and the contractor's temporary roads with associated potential damage.

Mitigation options

- ✓ Maximum use should be made of future permanent roads for site access.
- ✓ Rights of way for temporary access must be negotiated with all affected individual users, and any temporary loss of land compensated in accordance with mandatory procedures.
- ✓ Temporary access should not be permitted in the sensitive wetlands along the Tekeze River and elsewhere in and around the PCA.
- ✓ The condition of all non-paved public roads and all temporary access routes should be recorded and agreed with the concerned authorities and/or land users before use,
- ✓ Any damage to public roads should be made good to the satisfaction of the road authority immediately.

7.1.3 Impacts related to construction materials extraction

The contractor will require bulk materials for construction, specifically earth for embankments, stone for stone pitching, stonework and rip-rap (channel bed and bank protection), and various grades of aggregates (sand, gravel, crushed rock) for road construction and concrete; these will have to be sourced locally. There is a low possibility that asbestos-cement or other asbestos containing materials might be used in the works, besides materials suppliers (both national and international) have varying standards with respect to all aspects of corporate social responsibility.

Mitigation options:

- ✓ Maximize the re-use of excavated materials in the works, as fill,
- ✓ Use quarries and borrow pits carefully to minimize impacts,
- ✓ Obtain archaeological clearance for all proposed borrow pits and quarries,
- ✓ Strip all available topsoil from borrow pits and quarries and store it safely for use,
- ✓ Operate quarries and borrow pits so as to avoid creation of steep slopes,
- ✓ Close all borrow pits and quarries in accordance with an approved plan to maximize their long term biological productivity and minimize health hazards.
- ✓ Ensure sand is only sourced from mining agency approval.
- ✓ Ban all use of asbestos containing products (clause in the tender documents)

Figure 6. Showing environmental impact of construction material extraction

Source: Survey for the EIA study (construction materials extraction within the PCA)

7.1.4 Impacts of Spoil Disposal

The project will involve the excavation of soil and rock surplus or unsuitable for re-use in the works. This will require disposal.

Mitigation options:

- ✓ Maximize the reuse of all excavated materials in the Works
- ✓ Dispose surplus material at designated sites by approved methods and responsible authority
- ✓ No spoil should be disposed in areas of wetlands, watercourses, ecological valuables,
- ✓ Obtain environmental clearance for all potential spoil disposal sites in advance.

7.1.5 Pollution control and Waste Management

The construction process will involve creation of various solid and liquid wastes and the use of materials (fuels, oils and solvents) which may be hazardous for the environments.

Mitigation options:

- ✓ Identification of all waste streams, development of appropriate management methods based on the three Rs (reduce, re-use, recycle),
- ✓ The risk of accidents involving hazardous materials such as fuel can be minimized by a standard best practice approach involving such basic precautions secondary containment of all stationary fuel stores, vehicle maintenance only on purpose-built impervious concrete platforms with oil and grease traps, and standard operating practices for refueling mobile equipment.

7.1.6 Worker's Hazards

To build the project several hundred workers will be involved in construction activities over an estimated three years. This is highly likely to result in accidents and injuries to workers. Besides involvement of construction labor on offsite behavior should be governed by code of conduct.

Mitigation options:

- ✓ Ensure that the project proponent and financier signal that best practice of health and safety standards should applied.
- ✓ Include standard best practice health and safety provisions in the construction contract
- ✓ Include a specific task in the supervision contract concerning health and safety
- ✓ Establish an emergency evacuation procedure for casualties to an approved hospital.

7.1.7 The hazard of Flooding

The project involves the construction of more than 10 km of channels and associated structures in a floodplain subject to annual floods of varying severity and duration.

Mitigation options:

- ✓ Confine work on at risk structures to the dry season,(October to May).
- ✓ Ensure that all structures are completed by the end of the dry season or protected temporarily
- ✓ Plan and implement comprehensive revegetation measures on exposed surfaces

7.1.8 Direct Loss of Habitats

Channelization of the Tekeze and other rivers for drainage will change the configuration of the river beds and destroy the existing vegetation on the banks. It will also reduce or sever hydrological connections to the riverine wetlands and some seasonally flooded grassland, and could alter the morphology of the confluences with tributaries.

Mitigation options:

- ✓ Ensure the detailed design maintains effective hydraulic connections between all tributaries, Tekeze River and associated wetlands.
- ✓ Implement construction activities during the dry season between Nov and May to avoid the breeding season of the majority of fish species, which is the wet season.
- ✓ Construction zone limits should be identified and physically marked, to avoid key habitats, riverine wetlands and to off-site trafficking and damage.

7.1.9 Impact and disruption on wildlife

The construction process will create noise, dust, lights, vehicle movements, and human activities throughout the command nearby areas. It will also improve access to sensitive habitats and provide potential additional markets for natural resources. Especially since the project lay adjacent to ecologically sensitive areas like the hilegen denser shrub land and Kafta- Sheraro national park needs due attention during access road pavement.

Mitigation options:

- ✓ Use blasting blankets to minimize blasting noise (standard best practice for safety reasons).
- ✓ Use directional security lights that minimize casting light outwards or upwards (to reduce nighttime disorientation of night-flying birds).

- ✓ Physically identify sensitive habitats (specifically, remaining wetlands) and that workers do not enter these for any reason.
- ✓ Establish a ban on the purchase of wildlife products (e.g. skins, feathers) by all members of staff and workforce.

7.1.10 Permanent loss of land and buildings

The project's infrastructure, canals, drains, roads and flood dykes will occupy some significant size of land which permanently taken out of cultivation and or residential and farmstead structures. Since the project command area is highly congested by different development activities and previously planted infrastructures it needs serious attention during implementation phase of the project.

Mitigation options:

- ✓ Compensation for standing crops, trees and any other improvements or assets on the land, including to non landowners whose assets are affected, i.e. persons with houses or trees on land legally registered by other names.
- ✓ Provision of replacement land of equal quality nearby combined with proportionate cost of adjustment
- ✓ Measures to ensure no loss of income or livelihoods during the transition period to the new system.

7.1.11 Redistribution and Consolidation of Agricultural Land

The design of the irrigation system is based on standard farm-level irrigation units of 2ha (200 m long down slope and 100m wide across the slope). Each 2ha unit will be sub-divided into 4 independent plots of 0.5 ha each. Since at present households have, on average, 4 plots totaling 2.ha, and some percent of the total land in the PCA will be taken up by irrigation and road infrastructure, this implies reorganization of existing land holdings and a reduction of the average number of plots to per household. Procedures and mechanisms for land redistribution for "modern irrigation" are established by the relevant federal and regional legislation and the regional guideline. Under this process farmers losing land are allocated replacement land through a proportional adjustment of all the irrigation beneficiaries' land holdings, at the same time as consolidation of fragmented holdings to enable effective scheme management.

The project design assumes that the new WUAs will design and construct the necessary field ditches and field drains, and that farmers will themselves be responsible for the precise land leveling which is necessary for effective water management in irrigated vertisols. In addition extra labor will be needed for preparation of the new land; patterns of access will be changed.

7.1.12 Interruption of Access

The project will involves constructing main canals, drains and many field ditches. The canals will be kept full of water throughout the year to minimize seepage losses and the drains too partly. Except for the field drains, all channels will be sufficiently wide to represent a barrier to walking.

Mitigation options:

- ✓ Construct additional bridges and crossings as their need becomes apparent.

7.1.13 Impacts on endangered species and vegetation loss

The vast vegetation clearing will lead to loss of biodiversity especially of organisms that are prevalent in the areas. The area is also a home to many bird species and animals and therefore biodiversity loss will lead to the loss of habitats and interference in the migration corridors. The cutting of indigenous trees may interfere with some cultural values of the local community as some trees have energy and construction value and have been used for treatment purposes.

Mitigation

- ✓ Where possible, the clearing of vegetation more so the indigenous trees need to be avoided during construction as much as possible,
- ✓ Where clearing occurs the land should be landscaped and planted with as much indigenous vegetation as possible so as to restore the lost biodiversity.

7.2 Operation Phase Impacts

In this section analysis of predicted direct and indirect impacts during operational phase of the proposed project are present in detail.

7.2.1 Inadequate Skills, Labor and Equipment at Field

The project design assumes that Irrigation Water Users Associations will design and build the necessary field ditches and field drains and farmers will carry out all land preparation (leveling, creation and

maintenance ridges and furrows per household for dry-season irrigation), together with husbandry of commercial crops and the maintenance of a proportion of the irrigation and drainage channels. This will require high levels of labor at certain periods and need for new implements and skills which otherwise would reduce the project benefits.

Mitigation options:

- ✓ Provide technical and logistical support for on-farm construction to the WUAs, either through an addendum to the construction contract or through other options,
- ✓ Precise land leveling should be carried out by the project as a one-off capital investment. This should be done as part of the land redistribution and consolidation exercise, before the reallocated parcels are marked out in the field,
- ✓ Consider alternative irrigation methods, specifically basin irrigation, initially,
- ✓ Provide significant levels of support for ridging, through farmer training and equipment,
- ✓ Labour requirements can be reduced, for example by mechanization, or labor freed up, for example by providing domestic water near houses and by converting to fodder crops and stall feeding to reduce herding requirements,
- ✓ Moving from the traditional plough to other types of cultivation equipment would be a transforming step, but requires household financial resources that did previously exist at present, subsidized rental system is required.

7.2.2 Inefficient Water Use

Inefficient water applications pose a salinization risk. Associated issues related to surface irrigation include inexact irrigation, no flexibility in applying smaller water quantities and shorter irrigation intervals, hydraulic structures necessary for road and canal crossings and for flow control besides tertiary and extra canals occupy larger areas than would be needed for pressurized irrigation.

Mitigation options:

Convert to alternative irrigation technologies which use less water per unit of yield as soon as economic and skills conditions permit, or as soon as environmental monitoring indicates incipient salinization.

7.2.3 Poor and Inadequate Drainage

The project command area is only moderately to marginally suitable for irrigation due to semi evenly distributed slope, and in some small areas is not suitable; there is a need for an intensive drainage system in an area of extremely difficult drainage conditions; drainage of the PCA is affected by topography and soil structure. The return period level selected for the drainage design is different from the same level computed by another study; drain performance depends on good maintenance which may not occur in practice.

Mitigation options:

- ✓ Exclude the most sensitive areas from the scheme.
- ✓ Use irrigation technologies which minimize water logging risk
- ✓ Convert to alternative irrigation technologies as soon as economic and skills conditions permit, or as soon as environmental monitoring indicates incipient.
- ✓ Minimize water applications through farmer training and non-surface irrigation technologies.

7.2.4 Groundwater Rise and Secondary Salinization

Soils in the command area are almost all vertisols, clays which expand when wet and become impermeable. The groundwater is saline at shallow depth, incorrect water management and inadequate drainage could result in rising water table and salinization of the topsoil.

Mitigation options:

- ✓ Include soil and water monitoring in the full scale trial.
- ✓ Ensure farmers have knowledge and skills necessary to minimize surplus water applications,
- ✓ Establish water fees based on volumetric measurement,
- ✓ Enforce high levels of drain maintenance both on and off farm,
- ✓ Switch to other irrigation technologies,

7.2.5 Decline in Soil Fertility

Intensified cropping may result in a decline in soil fertility.

Mitigation options:

- ✓ Provide easy access to inorganic fertilizers
- ✓ Improve the fuel wood supply, so that manure is no longer needed for fuel.

7.2.6 Effect of Vertisols on Structures

The dominant soils in the command area are vertisols which crack when dry and swell when wet. Structures built on and in these soils could be affected by heave. In vertisols areas masonry structures are at risk of cracking due to soil shrinking and swelling and the resulting differential heave and subsidence.

Mitigation options:

- ✓ Design all structures, down to field level, to resist damage due to soil heave (e.g., using unitary construction, avoiding masonry, installing foundation platforms).

7.2.7 Erosion in Command Area & Sedimentation

Vertisols are highly erodible, even on gentle slopes as in the command area. Gullying is possible and could threaten the new infrastructure. The catchments below the dam site and adjacent to the command area are in poor condition, widely cultivated and heavily grazed, with low productivity and significant surface and other forms of erosion Sediment originating in these catchments will continue to affect watercourses downstream unless watershed conditions are improved. Despite the generally very low slope angles, the vertisols in the command area are prone to erosion which can rapidly become severe if runoff is concentrated. In vertisols, water passing outside hydraulic structures or seeping around them can rapidly create rills and tunnels and affect their stability. Livestock will trample and damage irrigation and drainage channel banks.

High population and grazing pressures and cultivation of all available land, including on slopes, have completely altered watershed conditions over most of the Tekeze river basin. The catchments of the rivers crossing the PCA are no exception. As a result, surface erosion is widespread, with significant volumes of sediment being moved downstream. Most of this geomorphologic work occurs during and immediately after heavy rains near the beginning of the wet season, when vegetation cover is sparse but soils have been wetted by antecedent rainfall.

Mitigation options:

Erosion within command area

- ✓ Vegetate all unlined channel side slopes, vermin, banks and any other exposed soil surface using non-invasive grasses. This should be done during construction, as part of the construction

contract, with subsequent maintenance by the O&M contractor using local staff responsible for specific, short reaches of the channels.

- ✓ Trial the use of vetiver grass for bank stabilization and erosion control in the command area, and promote if successful.
- ✓ Sediment input from upstream
- ✓ Consider extending successful practices piloted by ongoing land management projects
- ✓ Ensure that drain maintenance is adequate to maintain hydraulic performance of the main natural drainage channels

7.2.8 Potential Delay in Irrigated Agriculture Development

The project relies on knowledge-, inputs- and labor-intensive model of production at the field and household level. This model is untested under the environmental, social, economic and institutional conditions prevailing in the command area. If the model is not feasible, there will be a delay in project benefits as potential solutions are tested and applied. Changing this system to one based on double or triple cropping for both domestic staples and outside markets will require very large adjustments in household lifestyles and practices: new tools will be needed, and new skills, the need for cultivations will increase and therefore the demands on large livestock, labour demands over the year will increase above the existing high levels, with differential impacts on men and women. All this is without considering the requirements for new institutions, for crop processing and storage facilities, for marketing, and for changes in knowledge, attitudes and behavior.

Mitigation option

- ✓ A clear need for proof-of-concept at household level before scaling up to full implementation. This will be necessary in any case, as part of the research required to identify and develop the various extension and inputs packages that will be required

7.2.9 Impacts continuing and over Flooding on canals

Since the project area has poor watershed management and drainage system history a number of flooding events have occurred since the previous three years. Based n this scenarios, flooding could be risky to the area. Some Portions of the project command area will be flooded by channel discharges

with many years return period; this could cause important crop losses and physical damage to channels by siltation or erosion.

Mitigation options:

- ✓ Improvement of watershed conditions in the catchments upstream and below the reservoirs, with long term aim of reducing flood peaks and sediment loads.
- ✓ Channel maintenance, which includes maintaining the design profiles and cross-sections, maintaining the flood dykes, and removal of channel vegetation to maintain hydraulic performance.
- ✓ Designate flood buffer zones and manage them during high flood events.
- ✓ Prepare detailed flood hazard maps for the flooding impact zone
- ✓ Develop flood management and mitigation plans for adoption at local community level

7.2.10 Impacts of Inappropriate Reservoir Management

Improper reservoir management could result in inadequate water released for daily command area demands; excessive water released resulting in inadequate supplies to meet full dry season demands.

Mitigation options:

- ✓ Ensure fully integrated operation of the irrigation project and the reservoir based on comprehensive data on all aspects of the system's hydrology.
- ✓ Develop and implement a Reservoir Management plan
- ✓ Ensure the reservoir operating rules do not permit the operator to make sudden changes in releases, except in case of emergency.

7.2.11 Climate Change concern

As the environmental assessment have done in the project area extreme weather events and to some few three years climate change which is expressed in terms of higher temperature, extreme flooding, drought and desertification climate change and its long term effect could put its pressure in the project. Climate change could affect project operation through higher temperatures inducing higher water demands, more intense rainfall leading to intense floods and reduced rainfall and lower water availability.

Mitigation

Though, no specific mitigation measures are recommended for the project in relation to climate change and hydrology, the situation should be monitored closely so that appropriate measures can be taken to manage water resources at both local and sub-basin level.

7.2.12 Reduced Water Quality due to Pollution

During operation, the project is likely to have significant adverse effects on water quality unless mitigated. The principal areas of concern are pesticides and insect sides, fertilizers, salts, and waste, both solid and liquid.

Mitigation options:

- ✓ Conserve riverine wetlands to act as buffers,
- ✓ Develop and promote Integrated Pest Management (IPM),
- ✓ Carry out crop-specific research to refine fertilizer recommendations,
- ✓ Raise capacity of extension service to deliver recommendations to farmers,
- ✓ Consider the strategic options of promoting organic agriculture,

7.2.13 Changes in Pests and Diseases

The agro-ecological setting of the project area is highly suitable for the survival of different kinds of pastes and insects and so diseases. Intensification of agriculture is highly likely to result in the intensification of problems from pests and diseases. At present crop pests and diseases cause major economic losses in the PCA. Most damage is caused by insects, followed by weeds, storage pests, and plant diseases.

Mitigation options:

Targeted research on prevention and control techniques for the major insect, weed and disease problems in the area and development and delivery of appropriate preventive extension packages in problem avoidance and management techniques.

7.2.14 Habitat Degradation

The project will alter vegetation communities in the command area and its vicinity due to changes in hydrological conditions, and will also intensify pressure on the forest and some reservoir areas, especially by young people who do not have access to developed land within the command area, resulting in further loss of their economic value and ecosystem functions.

Mitigation measures are:

Manage the project to ensure that habitat diversity is retained, specifically by redrawing the project boundary to exclude development of some habitat area and develop and implement a forest and some endogenous plants restoration programs.

7.2.15 Continuing Impacts on Birds

The river is among the few international river basins in Ethiopia that has potential ecological area for bird accommodation. Especially in the area of pump station around heilegen different migratory and endogenous birds to the area are highly seen the plantation of pump station around this site could affect the survival of this bird species. The project area is extremely important for international migratory birds. The project will increase pressure on the natural environment resulting in degradation and loss of bird habitats.

Mitigation options:

- ✓ Avoid interruption such ecologically sensitive areas
- ✓ Awareness programs for local residents with respect to birds and their protection,
- ✓ Manage the project to maintain the integrity of the wetlands,
- ✓ Initiate a wetland restoration program and/or support existing wetland restoration initiatives.

7.2.16 Impact on the Kafta-Sheraro national park

Part of the project command area is fallen within the Kafta-Sheraro national park which lay between Adebay and Hilet Koka. Some part of the park will be used for pump station; main canal crossing and the construction activities could affect plants and wild life species.

Mitigation measures.

- ✓ As much as possible an alternative site could simultaneously proposed not to interrupt the park,

- ✓ Some international regulation could affect for funding to the project so this should be considered and any activity that could affect the park should be avoided.

7.2.17 Prolonged Exposure to Malaria

The project is likely to change the pattern of malaria infections during the year, with an extension into the dry season permanent (year-round) malaria is less dangerous than short, intense seasonal transmission, but malaria will continue to have a very high impact on human health, especially for children. Health interventions are essential to ensure that the project's social and economic objectives are reached, and reducing malaria morbidity and mortality in the region is a battle to be fought every day for a very long time.

Mitigation options,

Reduction of contacts between humans and Anopheles by the use of impregnated bed nets is useful. This has been proved to result in a reduction of the incidence of malaria. Together with efficient health facilities and health education, the general result of mass use of bed nets, preferably impregnated with a long lasting insecticide, is a dramatic decrease in malaria morbidity and mortality. However, the bed nets are fragile and do not last more than two or three years. Consequently, at present they are not available for each individual in all households. Moreover, they are not easy to use in houses without beds, and not all the residents are convinced of their effectiveness against malaria.

7.2.18 Mitigation for downstream and river function effects

Major concerns of this effect will be that the demand for water for irrigation comes during the dry season, when release levels are already low. Irrigation demands at this time may conflict with the demands of other uses such as ecological function of the river and downstream users.

Mitigation options

- ✓ The water balance, crop water requirement and other utilization strategies under the Tekeze River should consider and respect the use-right and some domestic, navigation and existing downstream irrigation practices of the downstream users.
- ✓ A minimum of 20% from the total stream flow of the river must consider for the sustainable ecological function of the river.

- ✓ A periodic stream flow monitoring and hydrological balance computing should be planned ahead of a use right conflict happen with downstream nations.

CHAPTER VIII: ENVIRONMENTAL MANAGEMENT AND MONITRING PLAN

8.1 Background

Based on Ethiopian environmental policies, laws and guidelines this proposed project falls within the category of projects that need a full EIA study> this EIA report has identified a number of potential environmental and social impacts for which mitigation measures has been developed and a management and monitoring plan is presented as below.

8.2 Environmental management plan (EMP)

A management plan is the process of implementing mitigation measures in accordance with the schedule of action contained in the EMP, together with any necessary adjustments to respond to unforeseen impacts or other changes. In order to make the program sustainable integration of environmental considerations for key development programs and projects is essential. Monitoring allows the measures and conditions attached to project approval to be fine-tuned in the light of new information. The primary aim of monitoring is to provide information that will aid impact management and continually; to achieve a better understanding of cause effect relationship and to improve environmental assessment prediction and mitigation methods. When used systematically, it facilitates impact management, built continuity in to the environmental and social impact assessment process and help to optimize environmental benefits at each stage of the project development. Environmental monitoring program has prepared for the proposed project for assessing the efficiency of environmental management plan implementation and to take correction measures in case of any degradation activity in the surrounding environment. Monitoring of the project operations, i.e. the physical environment and public health in the vicinity of social and ecological management facility is an integrated part of the design, construction and operation of the project. The responsible institute and authority, like the ministry of environment and forest, the regional EPA and the correspondent Woreda will easily monitor and evaluate the effective implementation of the mitigation parameters proposed during the environmental management plan. To facilitate this, monitoring parameters and their corresponding implementation measures have clearly been identified, quantified and presented in a summarized table below.

Table 11: Summary of Environmental management plan

S#	Potential impact	Mitigation measures	Project phase	Time frame	Responsible Institute	Budget (Birr)
1	**Biological Environment parameters**					
	Impacts on the existing flora and fauna Loss of flora	-Avoid cutting indigenous trees and vegetation within the survey area/ path of the water conveyance -Avoid excessive bush clearing; where possible adopt re-vegetation around the water intakes -Minimize number of indigenous trees cut -A forestation and reforestation programs in certain parts of farmlands -Preserve certain sections for grazing purposes The integrity of the forest resources should be well guarded from the spillover effects of the project‟ activities so as to maintain their functionalities	Construction and operation phase	Post operation season	Project owner and contractor	230,000
	Loss of fauna	- Construction within sensitive habitats should be avoided at all costs	Construction	Preconstruction season	Project contractor	Nil

S#	Potential impact	Mitigation measures	Project phase	Time frame	Responsible Institute	Budget (Birr)
		-Wetlands should be buffered by a minimum of 50 meters -Construction zone should be clearly indicated to prevent off site damage - Modifications of canal routes should be preceded by an ecological survey - There should be intensive tree planting - Setting aside woodlands				
	Destruction of Wildlife habitats	• The habitats diversity should be retained and protected by conserving them • There should be no cultivation on riparian sections since they serve as habitats for several animal species • Woodlands should be adequately established	Construction and operation	During construction season	Contractor and project owner	Nil
	Risk of Alien species, pests and aquatic weeds	• Managing canals so as to minimize weed growth.	Operation	Post-operation season	Project owner and local benefices	455,000

S#	Potential impact	Mitigation measures	Project phase	Time frame	Responsible Institute	Budget (Birr)
		• Avoiding stagnant water points that suit for aquatic weeds. • Monitoring and removing weeds before they spread and clog canals. • Keeping dry canals, drains and fields when crop watering is not required. • Implementing improved drainage and efficient water applications. • Use of resistant crop varieties. • Use of chemicals as the last option.				
Pollution-concern						
II	Air and Dust	• Provide dust masks to workers • Sprinkle water on the soil during excavation and land filling; • Control speed of working machinery	construction	During construction season	Project contractor	135,000
	Noise	-Abate noise by sensitizing drivers in the project -Use manual labour as much as possible. -Restriction of activities to daytime	Construction	During construction season	Project contractor	Nil if mitigated as proposed

S#	Potential impact	Mitigation measures	Project phase	Time frame	Responsible Institute	Budget (Birr)
		- Workers within the vicinity of high level noise to be provided with adequate PPE. -No idling of vehicles and machinery if not in use, they should be switched off. -Control speed and noise of construction machinery; -Insulate noisy machines and activities during construction to minimize noise impact to neighboring communities -Unnecessary hooting is to be avoided as much as possible				
	Water	-Keeping all equipment and machinery free from mud -having workable standard operating procedures while working along water resources -Apply appropriate irrigation procedures to prevent contamination -Sensible use of agrochemicals to prevent deposition into rivers -Adhere to waste discharge regulations -Compaction of loose material/soils -All repairs and maintenance work should be done at the contractors	Construction and operation phase	Post construction season	Project owner ,contractor and local community	Nil if it mitigated as proposed

S#	Potential impact	Mitigation measures	Project phase	Time frame	Responsible Institute	Budget (Birr)
	Water borne diseases	• Avoiding pollution of river water during concreting work from cement slag and oil and fuel spills by providing suitable diversion and/or other appropriate measures.	Construction	At the time of construction	Project contractor	Nil
	Water quality	• Use of environmentally friendly biocides. • Avoid releasing of drain or irrigation return water into streams and rivers. • Taking precaution in biocide spraying not to pollute water in the canals. • Conducting periodic water quality monitoring.	Operation	During and post operation	Project owner	Nil

S#	Potential impact	Mitigation measures	Project phase	Time frame	Responsible Institute	Budget (Birr)
Physical Environment						
III	Impacts on soils and Siltation	• Schedule construction for dry season. • Minimize compaction of soils and loosen compacted soils by plowing after Completion of works. • Provide appropriate cross and longitudinal drainage facilities including Lined side ditches for construction of any roads. • Refill the exposed or excavated soil soon after completion of works. • Keep land clearing and disturbance to absolute minimum. • Reduce the time surface remain bare following completion of works and establish vegetation cover on exposed areas/soils with appropriate vegetation. • Follow up and maintenance of erosion protection measures on roads, canals and drains. • Distilling program to clean silted up structures. • Efficient land and water management to reduce erosion.	Construction and operation	During and post construction	Contractor And project owner	1,200,000

S#	Potential impact	Mitigation measures	Project phase	Time frame	Responsible Institute	Budget (Birr)
	Impacts on landscape and visual amenity, and slope stability	• Minimize side-casting of excavation materials on down-slope. • Restore borrows sites, materials processing sites through back-filling, landscaping and re-establishing vegetation cover. • Replant and maintain vegetation to restore the natural appearance of construction areas. • Preserve the vegetation cover of the areas unsuitable for irrigation and implement enhancement measures.	Construction phase	During operation And maintenance season	Contractor of the project	300,000
	Sedimentation	• Implementing soil conservation measures in the catchments and command area to reduce soil erosion and sediment loads of the canals.	Operation phase	post operation	Contractor of the project	Nil

S#	Potential impact	Mitigation measures	Project phase	Time frame	Responsible Institute	Budget (Birr)
	Siltation and farm flooding	-Ensure proper design and layout of field to avoid canal on the steep gradients -Ensure there is appropriate terracing where possible -Ensure water application does not exceed soil intake rate, over irrigation	Construction	Post construction	Contractor of the project and project consultant	Nil
	Salinization/ Leaching	-Avoid water logged conditions, where possible -Add humus and organic manure to the soils regularly	Operation	Post operation	Project contractor and benefices	Nil
	Water Quality concern	• Avoiding pollution of river water during concreting work from cement slag and oil and fuel spills by providing suitable diversion and/or other appropriate measures.	Construction	During construction	Project contractor	Nil
Socio-economic and institutional settings						
	Land Repossessions and Relocation	• Stakeholder consultation and involvement in decision making at all levels ✓ Compensation of land to the farmers ✓ Provision of alternative land of similar value ✓ Skip areas where the crops are maturing to cut on the losses Measures to reduce loss of income to those affected by the relocations	Construction	Post construction	Project owner or the contractor as per the agreement	1,000,000

S#	Potential impact	Mitigation measures	Project phase	Time frame	Responsible Institute	Budget (Birr)
IV	Labor migrants pressure on scarce social service and employment	- Provision of alternative and additional social welfare prioritizing both the skilled and semi- skilled local labor ahead population planning and its consideration with the inhabitants - Expansion of available social service -Monitor the trend in migration to the area during the project implementation and increase the requisite facilities	Construction	Post construction And operation	Contractor, project owner and local government structures	Nil
	Health effect on the nearby society	- Implement awareness creation of eminent social evils such as HIV/AIDS and other STDs - Organizing community sensitization drives on the prevention and management of the HIV/AIDS - Liaising with the local organizations for the training and education on the right prevention mechanisms - Contraceptives should be provided at acceptable locations	Construction	Since construction and post operation	Project owner, relevant stakeholders and contractor	Nil, Part of the wereda annual health budget

S#	Potential impact	Mitigation measures	Project phase	Time frame	Responsible Institute	Budget (Birr)
	Impact on the existing urban land use pattern	- Exclude lands assumed by future urban land use plan - Search alternative irrigable land outside the urban fringes in the extensive cultivated land - Relate the project land use plan with the existing urban future plan and over to exclude some affected area.	Preconstruction	During designing time and construction	Project consultant, contractor	Nil if the proposed action is applied
	Use of canal water for domestic purposes	- Sensitize the community on the dangers of using canal water for domestic purpose - Consider the possibility of providing tap water - The local community should be encouraged to treat the tap water. - Ensure there is adequate sanitation facilities to be installed on sites - Warning signs/bumps to be erected and/or placed at risky points - There should be insurance covers for the workers under the workman‟s - Install at strategic points enough firefighting equipment	Operation	Post construction	Project owner, the public and relevant stakeholders	Nil part of the woreda's budget

S#	Potential impact	Mitigation measures	Project phase	Time frame	Responsible Institute	Budget (Birr)
	Possibility of Increased Conflicts	- Avail drinking points for the livestock along the canal or build the water pans along the canal - Fencing off the farms to prevent animals entry into the farms - Regular communal discussions and dialogue should be facilitated between to bring about mutual agreements between various land users - Other modes of grazing could be encouraged such as zero grazing as it is less pasture demanding - Fodder production can be done on irrigated land to reduce the pressure of over grazing - Establish local bylaws and irrigation management structures to handle the conflict	Operation	Post construction	Project owner, use community and wereda concerned offices	Part of the integrated project cost
	Institutional capacity building on irrigation/ water management	- Along with the introduction of surface pump irrigation, the capacity of the irrigation sector has to be built on irrigation/ water management through HRD, Training, equipment, etc.	Operation	Post construction season	Project owner, wereda relevant offices	500,000

S#	Potential impact	Mitigation measures	Project phase	Time frame	Responsible Institute	Budget (Birr)
	Water related Health hazards	- Avoid creating pools of water where insect vectors of diseases may breed. - Provision of adequate safe water supply, sanitary facilities, and health services for the project workers and local population. - Provision of adequate impregnated bed nets for the population in the project area. - Spraying the houses in the project area with insecticides.	Construction	From construction to implementation season	Contractor, project owner and wereda relvant stakeholders	Nil, part of the integrated wereda and project running cost
	Extended malaria Season and increase schistosomiasis	- Malaria diagnosis, treatment and management skills upgrading for frontline health workers - Repeated mass treatment of local population - Benet programme including LLIN distribution, education and training, and monitoring	Construction	Construction and post operation season	Contractor and wereda health office	Nil, part of the wereda"s annual health cost
	Impacts of transformation of livestock husbandry System.	- Continue implementation of the livestock programme as a major project component - Establish livestock corridors between fields	Operation	Post operation season	Project owner, beneficares and relevant wereda stakeholders	Nil

S#	Potential impact	Mitigation measures	Project phase	Time frame	Responsible Institute	Budget (Birr)
V	Climate change incident	- Plan irrigation systems to address ways and means of reducing GHG emissions without jeopardizing the beneficial effects of irrigation project. - Search research findings on devising ways and means to reduce GHG emissions, irrigation could become environmentally sustainable adaptation measure under climate change.	Preconstruction	Throughout project cycle	Contractor, project owner, EPA, local community and relevant stakeholders	Nil cost its sharing of legal responsibility
		- Encourage forestry Actions*:* encourage tree planting on the hills, community and private land and develop better management of forestry operations as trees absorb and store atmospheric CO2 and avoid forest fires not to release CO_2 - Minimize the off-take of woody biomass for construction and fuel and use other alternatives such as stoves, electricity, stones and cement concrete breaks instead of wood for house	Operation	Post construction	project owner, EPA, local community and relevant stakeholders	Nil cost its sharing of legal responsibility

S#	Potential impact	Mitigation measures	Project phase	Time frame	Responsible Institute	Budget (Birr)
VI	**Cumulative Downstream Effects**					
	Inadequate information for Planning	- Continue implementation of available information and prioritizing the establishment of hydrological monitoring and information systems.	Design	Preconstruction season	Project Consultant	Nil, part of the project detail study
	Impact on down users	- Regulate the demand flow - Ensure the minimum release to the lower riparian as high priority - Apply periodic stream flow monitoring and re-compute downstream demand - Develop an integrated water resources management (IWRM) plan based on actual hydrology. - Include a multi-stakeholder rule-making mechanism in the IWRM plan.	Operation	Since operation and maintenance	Project owner, users association	Nil, it needs effective management
	Environmental flow consideration	- Determine environmental flows for the river basin using multi-stakeholder process. Minimum of 20% of the lean flow.	Design	Pre construction	Consultant and project owner	200,000
	Reduced dry-season flows	- Regulate (augment) dry season flows at border using water regulating mechanism	Operation	Post construction	Contractor and users association	Nil cost

S#	Potential impact	Mitigation measures	Project phase	Time frame	Responsible Institute	Budget (Birr)
	Affect downstream water transport and economic tie of the riparian	- Consider the environmental flow and hydrological balance of the river basin by which that tolerate this effect. - The water balance, crop water requirement and other utilization strategies under the Tekeze River should consider and respect the use-right and some domestic, navigation and existing downstream irrigation practices of the riparian countries.	Design	Preconstruction	Consultant , contractor and water users association	Nil, utilization management arrangement need
Overall project mitigation cost			Project major impact's enhancing measure **cost=3,685,000**			
			Contingency (10%) **=368500**			
			Total project Environmental cost **=4,053,500**			

8.3 Auditing for EIA implementation and feedback mechanism

Periodic environmental auditing and monitoring is mandatory for effective implementation of the early designed management plan and monitoring parameters. The project proponent, responsible authorities federal and regional EPA and contractor of the project should conduct periodic audits to ensure the systems are operating effectively. The audit needs to ensure that:-

- The EMP being used is up to date,
- Variations to the EMP and non-compliance and corrective actions are documented
- The appropriate environmental training for personnel is undertaken
- Emergency procedures are in place and effectively communicated to the personnel
- A register of major accidents is in place and other documentation related to the EMP
- The appropriate corrective and preventive action is taken by the contractor once instructions have been issued.

The environmental management of the proposed project should strengthen the mobilization of the beneficiary communities with regard to environmental and health aspects and render the proposed irrigation project sustainable. The EMP has various components with the respective stakeholders involved towards the implementation of the corrective actions. The following should be involved in implementation of the EMP;

- project owner
- Federal, Regional and local EPA authorities
- Contractor of the project
- funding agency
- Relevant stakeholders
- Responsible local administrations
- Local community and beneficiary

The result of auditing processes in the implementation of the project and its correction measures if any gap appeared should be officially declared by a strong and responsible feedback through official written documents.

Table12: Summary Environmental Monitoring plan

	Environmental Components to be monitored	Monitoring Parameters	Frequency	Institutional Responsibility	Cost Estimate (Birr)	Remarks
	Soils	• Soil PH, EC, salt (e.g. soluble sodium) and water-logging • Rate of soil erosion and siltation of canals • Soil drainage efficiency and reduced water logging • Conserved status of soil	Twice per year	Water Resources Bureau of Tigray	25,000.00 annually	Significance
			Once per year	K/Humera W. Agriculture Office	15,000.00 Annually	
	Water Resources and Water Quality	• Sampling & analysis of physical and chemical parameters & biocide residues of water resources in the impact zone. • Effective utilization of irrigation water • Low and avoid contamination of agro-chemicals • pH Salinity (EC) Pesticide residues	Twice per year	Water Resource Bureau of Tigray	25,000.00 annually	significance
	Forest reserve area and park	❖ Avoid inclusiveness of ecologically sensitive areas ❖ Avoid and reduce deforestation and endangered of plant and animal species	Twice a year	Woreda and Regional EPA, WRDAO, kafta-sheraro Park authority		
	Wild life and endangered species	Avoid danger and destruction both on wild life and endangered species	Twice a year	Woreda agriculture Office and park authority	10,000	Significance

	Public Health & Social Infrastructure	• The availability of sufficient social infrastructure (health, education, water supply) in the project area; • Incidence of water related diseases (malaria, schistosomiasis & water-borne diseases); • Condition of vector breeding sites & vectors;	Twice a year	Woreda Health and Education Offices	40,000.00 per year	Highly Significance
	Misuse of irrigation water and conflict over	Effectively use water and settled conflict	Every quarter	Woreda WRMO	As per Yearly plan cost	significance
	Improved irrigation management integrated with crop & livestock feed production	Improved irrigation management integrated with crop & livestock feed production	Twice a year	WRDAO	30,000.00 Per year	
	Re-allocation of farmers who lost their farm land	Re-allocation of farmers who lost their farm land Preferably on irrigable command area	Twice a year	WRDAO	25,000 Per year	significance
IV	Cumulative downstream effect	• Mutual benefit and less controversial use • Avoid over utilization • Consult and consider downstream use right • Regulate environmental flow of the river	Every year	Regional and Woreda water resource agencies	50,000	Highly significance
V	Overall Performance evaluation and Status auditing	• Project ultimate goal achievements • Fulfilling of proposed environmental standards and early proposed enhancement measures	Federal and regional EPA, Woreda Agriculture Office	65,000.00 per year	Significance	
Estimated Total monitoring cost (Birr)				**300,000.00**		

CHAPTER IX: CONCLUSION AND RECOMMENDATION

9.1 Conclusion

This study has been carried out to equip the client with relevant and sufficient information about the proposed Tekeze - Humera irrigation scheme on how far the project could impact the environment both positively and negatively. It is anticipated that the proposed development project would bring substantial economic benefits not only to the local communities within the project area, but to the entire nation as a whole. It is also believed client would use this information to apply proposed measures to enhance the positive and mitigate the negative impacts.

The negative environmental impact on the implementation of this project is minimal and could be addressed by implementing the proposed mitigation measures to ensure that they pose no threat to the environment and communities. These measures are part of the project component and will bring some fair cost in the implementation process.

The benefits of implementing the proposed project are enormous and will address persistent problems of irrigation water shortage in the project area that has affected the communities for a long time. Typically, the Tekeze Humera surface irrigation project can bring about a number of short and long term benefits like:

- ❖ Enhance agricultural productivity and food security and reduced poverty
- ❖ Create huge seasonal and permanent job opportunity
- ❖ improved social and physical infrastructure
- ❖ Improve living standards of the people
- ❖ Efficient use of land and water resource
- ❖ Increase income
- ❖ Gender encouragement and benefits

To the contrary, this project could also bring about different adverse impacts both to the natural environment and the community. Which are tending to appear during the project construction and operation phase. Accordingly the major adverse negative impact of the project can be summarized as:

- Bio-physical (impacts on water, air, land , forest, soil and wild life)
- Socio-economic and cultural
- Institutional and
- Cumulative downstream effects

To list some detail adverse impacts the following found to be significant i.e., Loss of vegetation and land degradation, affect the nearby urban land use pattern, health issue especially the spread of malaria, water quality concern that could affect by agro-chemical misuses, impact on ecologically sensitive areas, water logging and poor drainage, displacement and relocation of land and people, loss g grazing land and health and social safety issues as well as downstream effect.

Despite of this, Majority of the negative impacts can be reduced to acceptable levels, except some immeasurable factors through integration of environmental mitigation measures in the design or planning and implementation of the project. Therefore, it can be concluded that there will be no irreversible or immitigable impacts that will prevent the implementation of this irrigation project that while the recommended mitigation plan is properly implemented.

In relation to its social acceptability, stakeholders and public consultations had thoroughly conducted at different level that is Woreda and community levels. Due to this, the outcome revealed that a high acceptance for the proposed irrigation project. This is largely based on the expectations that there will be opportunities for substantial increase in agricultural production and employment for local people, and thus, increased income level and improved living standards. Due to this, In order to have minimal and acceptable residual environmental and social impacts, and enhance the potential, a total Environmental mitigation cost is estimated to be 4,053,500.00 and necessary follow up of their effectiveness should be made through well planned monitoring programs with the cost of 300,000.00 Birr per planned year and a **total of**

Birr 4,353,500.00 for consecutive five years by concerned stakeholders to have minimal and acceptable residual environmental and social impacts and enhance the potential benefits.

9.2 Recommendations

In the previous topics the assessment indicated that different strategic actions should be taken to help ensure the project's feasibility and enhance its sustainability by proposing various environmentally sound mitigation options and enhancement measures. However, still there are sensitive and prioritized crucial issues of the study that need special attention through the project cycle.

It is important that during the implementation, the project proponent should be actively involved to address some of the cross cutting issues such as, natural environment, air quality, biological environment, Health, socio-economic and other relevant issues for their mitigation.

- The project is a bold attempt to transform agricultural production methods and yields and at the same time radically change living conditions in a poor and socially semi-rural society living in a difficult physical location with sensitive ecological values. This approach carries with it a number of risks, economic, institutional, social and biophysical. So the identified adverse impacts in this study should be respected by the concerned institutions responsibly.
- Majority of the project command area lay under the existing and proposed towns of future urban land use plan and investment sites (like in Humera town, Adebay, Rawiyan and Maykadra) this could be highly controversial and clash with other development arena so the proposed urban land use should excluded instead there is a plenty of cultivated land outside this impact zone that could be included early before operation.

- There is no previous experience of successful implementation of such mega project in large scale, modern and commercial based project in the area, therefore these risks are significant. Therefore the issue of institutional and community capacity building should harmoniously done.
- The project command area(the western Tigray especially that of Kafta humera Woreda) is among the few areas of the country by which ecologically sensitive and biologically endangered reserve areas and flora and fauna diversities are found because of this the impact on such specific impact zone would expect to avoid or put to be minimum

- Some part of the project reservoir area and .pump stations have proposed to lay within the kafta-sheraro national park around heilegen at Adebay and Hilet koka area, which is among the few protected areas of the country and endemic site of the Tigray regional state . in the case of international loan and fund raising for the project such act could not match with some financial institution's loan safeguards and over all the ecological balance of the park could disturbed for the sake of this the planting of pump station and main canal design should consider noise pollution, forest degradation altering of the usual wild life movement.
- The issue of water born and related diseases to the area is serious, especially malaria is endemic to the area such huge surface irrigation project could aggravate the incident rate appear before due to this the project owner, contractor and other relevant stakeholders should aware early to mitigate it.
- Majority of the PCA inhabited by different member of community which were immigrated by integrated resettlement programs in the previous years so a serious attention should made not to re-displace and relocate such strongly un stable community.
- There are minority groups of Kunamma community in the project area who have not irrigation practice experience had been lead their life as semi-pastoralist later changed to mixed agriculture so they should be treated in special capacity building program.
- There, exist similar projects in study area mainly focusing on potable water supply but sitting similar projects at same geographic area of interest would probably affect each other so a harmonizing mitigation approach to correlate both projects should early identified.
- The area is highly endowed by livestock resource but the entrance of such huge irrigation project could interrupt the usual grazing system of the area so a best action in adopting both activities mixing agriculture in the PCA would be highly feasible.
- Establishment of an efficient water application/management system to irrigation fields in order to prevent adverse soil modification like water-logging, and creation of mosquito and snail breeding sites.
- Such mega irrigation project would likely to utilize a bulky agro-chemical Application like pesticides and insect sides so a proper handling and use of agro-chemicals is recommended in accordance to environmentally friendly approach and acceptable relevant guidelines.

- Establishment of a strong environmental management and vector control and educational programs to control the transmission of water related vector-borne and STD diseases including malaria, schistosomiasis and Sexually Transmitted Diseases including HIV/AIDS.
- Enhancing market oriented production system using production enhanced technologies that lead to agro-industrial development.
- Establishing a monitoring program for checking the critical parameters like environmental flow of the river, adverse trans boundary effect, water quality, relevant soil characteristics, groundwater level, water-logging, and disease vector breeding places.
- The commitments of the key stakeholders including the Bureau of Agriculture, Tourism and Culture, Water Resources Bureau, Woreda and Kebele Administrations, Agriculture Offices, and Health Offices to implement the mitigation measures specified in the EMP and other necessary actions will be vital.
- For further project sustainability reasons this project needs additional future public disclosure and stakeholder consultation phase in order to resolve timely arising problems. Finally, It is important to note that to secure the effective implementations of such bulky measures allocating the necessary resources remain among the critical governing factors.

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In addition to the above the following materials have also reviewed

1. Constitution of Ethiopia, 1995
2. Federal Proclamation **No. 541/ 2007**
3. Federal Proclamation No**. 542/ 2007**
4. Federal solid waste proclamation **# 513/2007**
5. EIA Proclamation -proclamation # **299/2002**
6. Environmental policy of Ethiopia, **1997**
7. Ethiopian CRGE document of, **2007**
8. Institutional set up –proclamation # **295/2002**
9. Industrial policy of Ethiopia, **2010**
10. **Proc.No.300/2002** pollution control
11. Regional rural land proclamation no **136/2000**
12. Regional pollution control proclamation **No.300/2003**
13. Regional EIA proclamation of Tigray, **200/2003**

Annexes

WQM-permanent recording sheet

S#	Assessed district	Specific locality	GCP-remarks			Sample water pick source	EC-indicator findings				Remarks
			X	Y	Z		EC_w	TDS	Saline	RSTV	
1	**Tekeze-river**						In-dS/m	ppm	In-%	In-kΩ	The Examining g date is held in, 9/06/07-15/06/07 E.C At-8-12 am And 9-6 pm
	Sam-1										
	Sam-2										
2	**Adebay**										
	Sam-1										
	Sam-2										
3	**M/kadra**										
	Sam-1										
4	**Bereket**										
	Sam-1										
5	**Rawiyan**										

Project- nature: _____

Investigated by: _____

Position: _____

Examining date: _____

Time: Am_____ Pm_____

A Signup Sheets for Permanent Records of Public Hearing For EIA Study

District: _____ **Venue:**_____

Ward/Village: _____ **Date:**_____

S#	Name of The Participant	Age	Sex	Occupation	Designation(position)	Signature
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						

A public hearing stage during scoping of EIA draft, TWWSDSE

Rapid Environmental Assessment Check list

Project name/location:		***Assessment: draft/Revi/Final***	
Assessor's name/position:		***Date:***	

ID	**A. Project Sitting** Is the project area…?	**Impact rating (short screening response) (X)**			Remarks
		Yes	N/A	N ɔ	
I	Densely populated?				
	Heavy with development activities?				
	Adjacent to or within any nsitive environmentally seareas?				
	Protected Area				
	Wetland				
	Buffer zone of protected area				
	Special area for protecting biodiversity				
	Socially sensitive infrastructures				
	Water availability scar e area				
	Socio-cultural settings				
	Religious site				

II	Cultural heritage site				
	Other belief and custon area				
	Endogenous and minrity group				
III	**Others**				
	Endangered species				
	Area in rehabilitation				
	Sensitive infrastrucure				
	Geo-politics dispute zone				
	War front				
	Military area-zone				
	Hydro-geopolitics issue				
	Others if so……				

Impact screening checklist

A. Potential Environmental Impacts Will the Project cause…	Can cause			Degree of incidence			significance of impact			Trans boundary effect				Remarks
	yes	N/ A	No	ukn	low	mid	high	insegnific	Moderate	Sever	local	regional	International	
Exclusion of specific groups from the irrigation scheme allocation process due to lack of knowledge.														
Can affect the adjacent urban land use pattern														
Affect minority group														
Lack of training of workers in charge of irrigation water system operations (exploitation)														
Increase pressure on existing social services due to population immigration.														
Increase in diarrhea and other illnesses due to drinking reservoir and canal water														
Degradation of air quality and ambient noise due to construction work.														

Contamination of surface and underground water														

Obstruction and clogging of canals by weeds and sedimentation increasing standing waters and vector breeding sites														
Over use and miss use of irrigation water														
Lack of access to markets														
Water logging due to excessive irrigation														
Change in soil chemical properties PH, salinity, fertility etc.														
Loss of vegetation due to land clearing														
Creating habitats for animal diseases reservoirs and vectors														
Loss of cultural heritage (archeological and historical sites)														
Population pressure due to the arrival of migrants attracted by new economic opportunities														
Expansion of illegal and Unplanned human settlements														

Restriction for livestock grazing														
Disputes on water access and rights														
Failure to achieve production targets														
Pressure on natural resource due high immigration (energy, water, etc.)														
Water-borne diseases e.g. diarrhea, and cholera associated with poor sanitary conditions and misuse of irrigation water for domestic purpose														
Water related disease like malaria and others associated with increasing in vector breeding and contact														
Water washed diseases like scabies and skin infections with poor sanitary and hygienic condition														
Poising associated with excessive mineralization of irrigation water.														
Less water for downstream users														
Loss of water from seepage and evaporation														
Loss of fisheries														

Increased work load of women														
Disruption of traditional cropping systems														
Erosion or sedimentation of canals														
Wetlands destruction														
Increase in weed pressure														
Increased agrochemical contamination														
Disruption of livestock systems														
Failure to achieve production targets														
Poor water distribution														
Inequitable allocation of irrigated plots														
Faulty design and construction														
Siltation of reservoirs (ponds)														
Difficulty in land leveling														

Miscellaneous Check list

PART-II

Environmental baseline, impact assessment and natural resource appearance analysis

6. Land use pattern of the kebelle

- **Total area**_____
  - ✓ Cultivated land _____
  - ✓ Grazing_____
  - ✓ Forest and reserve area_____
  - ✓ Settlement_____
  - ✓ Park _____
  - ✓ Wet land_____ Others _____

6.1. Vegetation cover and variety of species_____ wild life_____

6.2. Majority cover plant SPECIES IN %_____ _____

6.3. List endangered plant and animal species

_____
_____
_____
_____
_____

6.4. Describe the reason behind the endangering event of such species?

_____
_____
_____
_____
_____

6.5. Past experience and current practice of the kebelle in Water shade Management including current achievement

6.5.1. soil water conservation in ha _____

6.5.2. Biological conservation in ha _____

6.5.3. area closed in ha _____

6.5.4. SWC coverage in % from total area _____

6.5.5. Plantation in hr_____ survival in %__

6.5.6. parks and reserved area _____hr

6.5.7. bad and best land use and management practices of local community practice

_____
_____

6.5.8. Number of cases by deforestation submitted to court and settled in the past three years, 2004,2005,2006 please quantify it.

6.6. Explain the general condition of environmental degradation , and deforestation, soil erosion, flooding and others cause-effect trends:

6.7. Is there any effect of soil structure and composition change (disorder) that can site as a result of traditional farming practices?

6.8. Describe the history, culture and attitude of the community towards sustainable land management in private land

6.9. Is there any occurrence of invasive alien species entrance from another area could you estimate the coverage and duration of occurrence???

6.10. Is there any extreme weather event or natural disaster in your locality that can affect such irrigation project??? When does it occur, 2004,2005,2006,2007

6.11. Is there any climate change incident in your locality in the past and in recent time how it happen brief shortly.

6.12. How can u describe the state of animal population pressure and grazing balance rate in your locally? Number of all animal population _____ grazing rate ___
if so animal population immigration, _____

6.13. is there any animal out break disease seen recently _____ when, how, number ___

6.14. What do you think be the major challenges, constraints and potential of this locality in implementing such irrigation practice???

6.15. What potential adverse environmental impacts could come about this project and what risk minimization measures would u recommend to wards better implementation approach of this project??

Summarized checklist for environmental baseline data organization from different sector and cross sector institutes and relevant stake holders

Water resource and mining office

1. **Is there any irrigation practice in your locality describe the existing and potential irrigation structures.**

ID	Exciting irrigation structures	Actual irrigable land currently, Hr	Potential for irrigation	Potential Irrigable land
1	Check-dam		Check-dam	
2	Diversion		Diversion	
3	Private pond		Private pond	
4	Community pond		Community pond	
5	Roof-catchment		Roof-catchment	
6	Spate		Spate	
7	Pumping		Pumping	
8	Others		Others	

Source:

2. **Describe the hydrological setting of your kebele, if there is rivers, spring, ponds, wetland and other including their specific area and official name.**

ID	Exiting water bodies	Official Name	Specific locality	Potential
1	Rivers			
2	Spring			
3	Ponds			
4	Wet land			
5				
6				
7				
8				
	Total			

3. Is there any mining activity, if so what kind of minerals and construction materials have been extracting and quantity it their corresponding volume of production till 2006 E.C

_____
_____
_____
_____
_____

4. What is the source of energy by which the majority of society utilized ever…???

_____
_____
_____
_____
_____
_____

5. List down the alternative energy source and the different energy saving technologies introduced till 2006.

Corresponding Year	Types of energy saving technologies						Remarks
	Imp/stove	Ele/stove	Ele/cooker	lakech	Solar-home	D-light	
Till-2006							
In-2007							

A summarized checklist for environmental baseline data organization from different sectorial and cross-sectional institutes and relevant stake holders

Urban-environment aesthetic value and waste management practice

1. What is the general condition of waste management and urban greenery practices in your town kebelle, how do you evaluate the status its trend

_____
_____
_____
_____

2. The volume of waste generated and safely managed _____

   2.1. Generated waste in metric tone_____

   2.2. Safely treated or managed in M^3_____

3. Is there land fill site, if so number _____

   3.1. Solid waste ground_____ area(size) _____

   3.2. Liquid waste num_____area(size) _____

4. Urban greenery and aesthetic value related activities

   4.1. Green area_____ hr

   4.2. Parks_____hr

5. Sewerage and waste treatment canal length _____

6. Volume of waste converted to re-use or recycled _____ 3

_____

7. Challenges in waste management, if there exist, also the best practices

   7.1. Challenges ever seen

_____
_____
_____

7. Best practices

_____

A summarized checklist for environmental baseline data organization from different sectorial and cross-sectional institutes and relevant stake holders

Health-office

1.List the number of health service centers in your locality and their capacity of serving patients per year averagely?

1.1. health center, numb_____serving capacity (number of population

1.2. health post,_____

1.3.clinic including private,lower _____ mid_____ total population

1.4. pharmacy, _____ drug shop_____ drug vendor_____

1.5. Others if so _____

2. The number of human population who get health service in 2006 _____

_____

3. Explain brefly the top ten diseas and the victims of each correspondent disease ever seen in your locality(Kebelle) since,2006

1. 6._____
2. 7._____
3. 8._____
4. 9._____
5. 10._____

4. Is there any disease out-break event of new case, in the past three years, when was that (the year), what was the nature of the diseases and quantify it the number of incident in specific period of time ?

4.1. If so when were the year_____

4.2. What was the nature of the disease_____?

4.3. How many people were affected by the incident_____?

5. Was there any water born or related disease occurrence in the past three years ever if so specify it when and how many group of society vulnerable?

_____
_____
_
_____
_

_____

_

_____

6.. Hygien and sanitation how many formal latrines are by now functional in your, kebele and quantify the number of people benefited from the service _____

7. is there waste management practice in your health center compound, land fill site _____ inclinator _____?