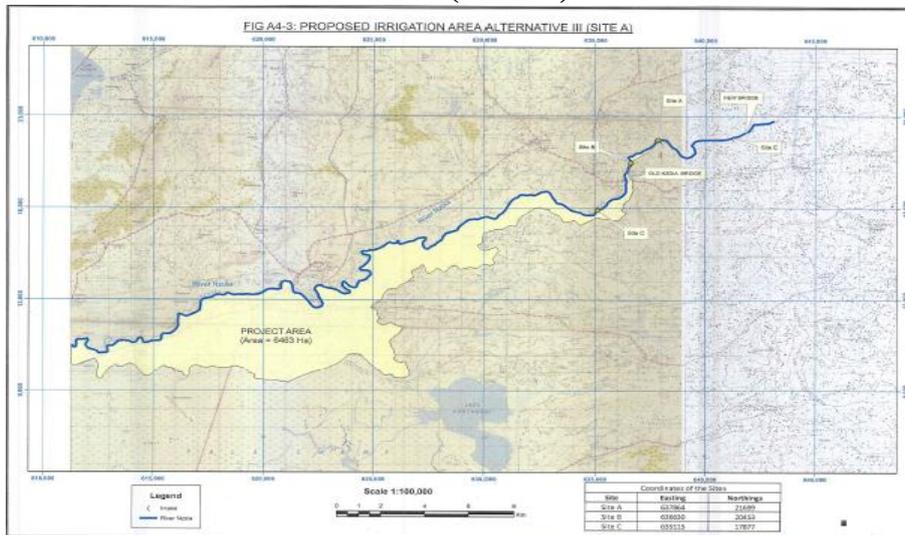




**NATIONAL IRRIGATION BOARD
KENYA**

**LOWER NZOIA IRRIGATION DEVELOPMENT
PROJECT (LNIDP)**

**ENVIRONMENTAL AND SOCIAL IMPACT
ASSESSMENT (ESIA) REPORT**



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1 EXECUTIVE SUMMARY

This report covers findings of Environmental and Social Impact Assessment (ESIA) study that was originally conducted by ESF Consultants and thereafter updated by the Water Security and Climate Resilience Project (WSCR) Lead Safeguards Specialist and Consultant-Tito Kodiaga.

Project Rationale

The Lower Nzoia Irrigation Development Project (LNIDP) will involve the construction of new water abstraction, conveyance, and distribution and drainage structures. It will also involve the construction of inspection and farm roads along the major infrastructure and farmers' fields.

This goal is consistent with the overall goal of agricultural development policy in Kenya as encapsulated in the Agricultural Sector Development Strategy (ASDS) and Kenya's Vision 2030. The proposed Lower Nzoia Irrigation Development Project (Phase I) would contribute toward addressing the aspirations of agricultural development policy in Kenya, as envisioned in the ASDS and Kenya's Vision 2030.

Project Objective

The higher level development objective of the project is to increase food production and food security, including access to better nutrition and enhanced standards of living for the local communities in the project areas. Key indicator to measure the achievements of this goal is the increased agricultural production. The project development objectives are to revitalize agricultural development in the project areas by enhancing the production of high value crops and increasing employment opportunities and income for smallholder farmers within the project areas.

Project Design and Benefits

Lower Nzoia Irrigation Development Project is located in the Lower Nzoia Basin that covers Siaya and Bunyala Districts. The area is project area lies within latitude 0° 04'N and 0° 11'S and longitude 33° 57'E and 34° 14'E. The proposed project area is a floodplain for Nzoia River without much natural ecosystem. The area is bordered on the south by Yala swamp and to the north by Nzoia River. The area is occasionally cultivated save for the seasons when it floods.

The Lower Nzoia Irrigation Scheme will focus on improving agricultural production through the rehabilitation of the already existing Bunyala irrigation scheme (which covers 705 ha) and the expansion of the irrigated area by about 3,336 ha¹. The scheme is located in the lower part of the left bank of the River Nzoia, and will benefit about 2,100 small farmers' households who hold an average of 1.92 ha of net irrigable area.

The project is designed to include three major components namely:

¹ A Baseline Survey showed that two thirds of the farmers in the project area possessed documents to prove their land ownership while the other one third did not have these documents but it was understood that the land was communally owned and known as such while ownership was not in dispute.

1. Component 1: Irrigation and drainage infrastructure (I&DI);
2. Component 2: Agricultural support and Chain Value (ASCV); and
3. Component 3: Participatory Irrigation Management (PIM).

The Agricultural support and Chain Value (ASCV) and the Participatory Irrigation Management (PIM) soft components together with the Irrigation and Drainage Infrastructure (I &DI) component will create the conditions for the transformation of the Lower Nzoia Irrigation Project area into an intensive and efficient irrigated production system. The ASCV component would assist in setting up and financing support to a sustainable and inclusive value chain development intended to help farmers not only to produce enough food for household consumption but also to grow and market high value crops and thus earn better and higher incomes.

Through the PIM component, the project will strengthen the system management by both NIB and farmers through their Irrigation Water Users Associations (IWUAs). The National Irrigation Board (NIB) would be responsible for managing the head works, main canal and its pertinent structures, while Irrigation Water User Associations (IWUA's) would manage the branch (secondary) canals, tertiary canals and other water courses.

Project Cost

The total project investment costs comprise both investment and operation and maintenance costs. Investment costs are further divided depending on the three major components as described above. The total investment costs for the scheme is around **Kshs 4,210,686,864 (USD 49,537,493; 1 USD = Ksh 85)** of which the Irrigation and Drainage Infrastructure (I&DI) component would take 77.1 percent, the Agriculture Support and Chain Value (ASCV) 11.2 percent, the Participatory Irrigation Management (PIM) and Project Management component 11.7%. The cost per component is as follows:

Table 1: Summary Financial Investment Costs

Component	Kshs	USD
Component 1	3,248,186,864	38,213,963
Component 2	470,000,000	5,529,412
Component 3	492,500,000	5,794,118
TOTAL	4,210,686,864	49,537,493

Environmental and Social Impact Assessment Study Objectives

The objective of this study was are to analyze the socio-economic and socio-environmental status of the affected areas during pre and post construction, assessing the Government's (National Irrigation Board's) capacity to implement the proposed mitigation measures, and make appropriate recommendations, including potential capacity building and training needs and their costs, identification of projects potential environmental and social impacts resulting from the projects and proposing mitigation measures, developing a work program, budget estimates, schedules, staffing and other necessary support services to implement the mitigation measures, preparation of emergency response measures to accidents as appropriate e.g.: entry of raw sewage to river systems, flood damages and designing Environmental and Social Management Plan (ESMP).

A scoping study was undertaken at the beginning of the study. This process involved consultation with the client, and all the relevant key stakeholders who were identified through stakeholder identification process. After the scoping process, a detailed literature review on the existing baseline information and research undertaken in the projects area was collected. The review of available data sources helped in describing the environmental and social set up of the area. After the literature review, a field survey was undertaken.

Potential Adverse Impacts

While the project objectives will be achieved, there are potential adverse impacts that will emanate from the project activities. It should be noted that all these impacts can be effectively be mitigated through a design, management, policy, capacity building and proper planning. The study proposes measures for mitigating the identified adverse impacts while promoting the benefits. The potential adverse impacts and mitigation measures include:

Physical Environment

Water Wastage

Water wastage is a potential adverse impact that is likely to be experienced if the LNIDP is implemented. The Design Consultant Otieno Odongo and Partners (OO&P) in their Final Design Report of April 2012 used 85% for Conveyance Efficiency and 60% for On-farm Efficiency giving the overall efficiency of 51%.

Mitigation

For losses through ground seepage, the transfer canals should be lined. This will prevent ground seepage of water in loose soil. The irrigation farmers can adopt water saving irrigation approach. The basic feature of water-saving irrigation is that there is no water layer on the fields throughout 75%-85% of the rice growing season when the air temperature is lower than 18°C during the early stage of tillage. This impact could be mitigated through adoption of these Chinese rice irrigation system where the paddies are drained during the day time and flooded in the evening. This method of irrigation has proved to be efficient in water usage. Under water-saving irrigation systems saves water loss up to 67.1%.

Changes in Hydrology

The abstraction of water from Nzoia River will have impact of the hydrological flow of the riverine system. The impact will affect the general hydrological flows including current existence on the shores of Nzoia River. This is an operational impact that will be permanent in nature. The highest irrigation water requirements is in July and it amounts to 4.03m³/s and 2.1m³/s for phase I and II respectively, while the environmental flows (0.3 f Q₉₅) amounts to 8.21m³/s which leaves 43.72 m³/s as surplus in the river in that month.

Environmental flows Assurance

Kenyan regulations require that 30% of Q₉₅ of the base flow (lowest mean semi-monthly flow) be retained as environmental flow requirement. NIB states that upstream and downstream demands have been factored in to water availability calculations because there is plenty of water going downstream to Lake Victoria in most of the year after meeting the environmental requirements and the irrigation water requirements. To reduce the impact of the projects on the basin hydrology, the

irrigation design should not divert more than 30% of the water flowing in the river. In case the design abstract more than 20% the return flow from the farms should compensate for this flow.

Soil Erosion

During the preparation of the land for irrigation, clearance of vegetation from the area will expose the soils to agents of erosion, mostly water. This impact will occur during project construction and operational phase. The magnitude of this impact will include reduction in soil productivity and siltation of shores of Lake Victoria downstream. This impact will be long term and will manifest after a long period. Soil erosion could occur during the construction phase when loose soil is swept by waters and during the operational phase during irrigation and field preparation.

Mitigation

Soil erosion can be avoided during the construction and operational phase of the projects. To avoid soil erosion a number of measures are proposed. These are;

1. Avoiding vegetation clearance that will expose soil to agents of erosion during construction phase.
2. Revegetating the cleared sites with local species of vegetation
3. only clear areas earmarked for construction and
4. Mitigation of soil erosion during cultivation will be through terracing of the sloppy areas of the land and plating of Napier grass along the canals.

Waterlogging and salinization

In the places where the soils are saline and poorly drained as is the case in the southern part of the project area, salinization could occur during the operational phase of the project. The larger component areas of this project consist of low lying lands. This means that incidence of irrigation salination in the project area will be high as there will be a lot of water logging. Irrigation salinity is the accumulation of salts in the topsoil under irrigation. It is caused by over-irrigation of agricultural land, inefficient water use, poor drainage and the irrigation of unsuitable and 'leaky' soils.

Mitigation

Alternative mitigation measures for this impact will be to use of salt-tolerant crops and managing the soils in the saline area identified. The salts should be leached by applying more water than the plant requires to below the root zone and use of the designed drainages which will move the salts away from the root zone to locations in the soil, other than below the root zone, where they are not harmful. Irrigation salinity is a water balance problem and will be managed by reducing groundwater recharge through:

- Avoiding over-irrigation by using irrigation techniques such as drip irrigation, monitoring soil moisture to determine when the soil needs irrigating and matching water applications to plant water requirements
- Using deep-rooted crops and pastures to minimise deep drainage
- Grow salt-tolerant species on salt-affected land
- Engineering solutions such as subsurface drainage to intercept deep drainage, surface drainage to collect surface runoff or groundwater pumping.

Surface Water Resource Pollution

Water quality could deteriorate significantly due to reduced water recharge and balance leading to stagnation contributed by upstream use of fertilizers. Agrochemical pollution could become a major problem with intensification of monoculture.

Mitigation

This impact can be reversible if Integrated Pest Management (IPM) approaches are undertaken or farmers are trained in techniques of agrochemical applications. An Integrated Pest Management Plan (IPMP) will be developed for managing pesticides. A training program should be developed for farmers on precautionary measures required for the handling, labelling and application of agro-chemicals under field conditions. Buffer zones (conservation areas) should be created downstream of the project area especially before reaching the Yala Swamp wetland. These buffer zones will filter pollutant loads from upstream and those leaching from irrigated farms. This mitigation measure is in line with the Kenya National Wetland Policy on Water Purification, Nutrient and Toxic retention. Artificial engineered wetland/ponds should be designed to act as buffer zones and filter water prior to draining into the Yala Swamp as a mitigation measure.

Sub-surface Water Contamination

Infiltration of irrigation water in excess of available root zone storage will penetrate beyond the reach of roots and eventually recharge groundwater. Nitrates, salts, and other chemicals used in crop cultivation that dissolve in the soil water will move with the water. Crops with high water and N requirements (rice and vegetables) will increase the potential risk of nitrate pollution to groundwater.

Mitigation

Mitigating against ground water contamination will require similar measures as used in preventing surface water pollution. Preventive measures will include practicing IPM and rational application of fertilizer only as a last resort while use of organic manure to be encouraged.

Reduced Water Flow

Off-take of water for irrigation will result in reduced stream flows especially during the dry season. Rice will typically require anything between 1000mm and 3000mm of water per hectare per season depending on management efficiency including field losses. For a project of 3,500 Ha therefore, water requirements per season will range between 3,500,000mm and 105,000,000mm. These are the amounts of water that will be abstracted from R. Nzoia to undertake growing of rice.

There are different ways to calculate the Environmental flows, but in the Feasibility Study (Sabbour and CAS), they used 30% of the Q95 base flow as a requirement for environmental flows. The calculations for the water requirements according to the revised cropping pattern; confirms the availability of the environmental flows in the critical month of July. **Table 5** which also shows the water balance and environmental flows and water availability after meeting the requirements of Phase I & II as well as the environmental flows. The highest irrigation water requirements is in July and it amounts to 4.025m³/s and 2.310m³/s for phase I and II respectively,

while the environmental flows (0.3 f Q95) amounts to 8.21m³/s which leaves 43.72 m³/s as surplus in the river in that month as shown in the tables below. In addition, there will be about 30% return flows from irrigation plus the small side tributary rivers downstream the weir.

Mitigation

There is a need to install master meters as part of the infrastructure to be developed. The master meter will be used to control the amounts of water abstracted from the rivers thus allowing for management of water flow downstream. Introduction of water abstraction fee for the project beneficiaries will also discourage wastage and conserve water use.

Flooding

Constructed irrigation drainage and networks will increase the flow of water in the lowlands. This effect compounded by reduced vegetation will reduce holding capacities of the area, thus increasing flooding potential downstream. This is cumulative impact as the area experiences flooding occasionally. The construction of the weir will flood a water surface area of 379789m² upstream of the weir. During the high flows of Nzoia River in the months of May to September, floods will occur upstream of the weir and might submerge arable land on the banks of the River.

Mitigation

Most of the rivers and streams within the Nile River Basin catchment are prone to flooding. Flooding can only be controlled through reforestation of catchments, protection of river banks, and manmade structures such as dykes that will reduce the flow of water. There will also be need to strengthen already existing dykes along River Nzoia so as to minimize chances of the river breaking banks and spilling water into the project zone. The component on catchment and hillside management should promote catchment management especially upstream to control the intensity of the floods. The river banks of the channels leading the irrigated area should be protected to prevent water breaking the banks and flooding the fields. Flooding of the surface area of 379789m² upstream should only be along the river course to avoid land inundation upstream. To avoid this, the weir should have overflow spillway.

Microclimate Modification

Loss of vegetation cover in those areas to be irrigated will lead to modification of the microclimate in the project area. The vegetation of papyrus and typha, for instance, favours water retention and regulates the temperature, thus creating a micro-climate favourable to the formation of organic soils. Therefore the loss of this vegetation will lead to loss of organic soils in the project areas. This impact is cumulative in nature as the project areas are already under agriculture with activities not directly related to activities of this project.

Mitigation

This impact is unavoidable and therefore a compensation strategy that enhances similar habitat is proposed. The parts of the project area downstream that will be remain after development of the irrigation infrastructure should be protected and conserved to provide the services. Also to recover the services of the microclimate, planting of trees should be undertaken to create that ambient climate similar to what was in existence before.

Topsoil Stock Piles

During the construction phase, excavation earth from the weir in addition canals and drainages will create a pile up of soil. These activities may result in the increased erosion in areas where vegetation has been stripped and stockpiled. This could lead to increased suspended solids being deposited into the streams, Nzoia River and Lake Victoria at the mouth of the river.

Mitigation

Stock piles should be adequately secured through installation of soil traps until they can be moved elsewhere for reuse. Where possible, such soil stockpiles should be used to rehabilitate stripped and excavated zones so as to reduce incidences of stagnant water and pools which would be a safety risk for people as well as breeding grounds for mosquito.

Land Use Change

The project will change land use from grassland and farming land to irrigated farmland. A total of 3,500 Ha will be converted from present use to irrigated farmlands. This is a permanent impact that will reduce the area under conventional agriculture and/or grazing land use. Present land use can revert back to its status after decommissioning of the project but it will take a long period of time before the rejuvenation of the current habitat/vegetation.

Mitigation

This impact is unavoidable and can only be compensated through allocating those who will be displaced from their farms and conservation of natural habitats downstream. To enable sustainable land use in the project areas, an integrated land use plan should be developed within the catchments based on the three tier approach that considers wider Nzoia catchment, middle grounds and the lower areas (project area). This impact will be well understood and mitigated during the development of the Resettlement Action Plan (RAP).

Greenhouse Gas Emission

Greenhouse gas (methane) will be emitted from the rice paddies through methanogenesis process. The cumulative effects of greenhouse gas effect on the climate results in global warming. This is a cumulative impact as the paddies will emit GHGs during anaerobic decomposition of organic matter in the paddies. Though some of the methane produced will be oxidized by methanotrophs in the shallow overlying water, the vast majority will be released into the atmosphere.

Mitigation

Addition of compounds such as ammonium sulphate, which favour activity of other microbial groups over that of the methanogens, will reduce emission of methane from the paddies. However this measure has its own environmental impacts. Alternatively there are many rice varieties can be grown under much drier conditions than those traditionally employed, with big reductions on methane emission without any loss in yield.

Siltation of Water Bodies

The source of water for this project is the River Nzoia. It feeds into the Lake Victoria and in extension the Nile Basin hydrology. Already, siltation is of major concern among all major rivers feeding into the Lake Victoria. The main source of such

siltation has been catchment activities that have resulted in poor soil management, deforestation and apparent soil loss. So far, siltation is one of the major factors blamed for bank bursting and flooding along River Nzoia. Irrigation on the lower Nzoia will contribute to siltation of the river mouth into Lake Victoria increasing the problem of flooding.

Mitigation

To prevent siltation of the River Nzoia, a catchment rehabilitation process should be up scaled to protect the soil from water runoff. There is need for a wider River Basin Catchment Management Plan to ensure protection of the catchment areas. This measure should be supported by creating buffer zones downstream of the area to trap the silt. Wider consultations and engagements should be sought by NIB to improve catchment management in the entire basin. A Strategic Environmental and Social Assessment (SESA) of the entire Nzoia basin is recommended to address issues of catchment protection and related cumulative impacts.

Climate Change Impacts-Extreme Drought

Climate change effects especially extreme droughts may compromise the ability of the River Nzoia to function as a system including social support services like irrigation and water supply. During extreme drought the availability of water for ensuring environmental flows and supporting the irrigation scheme may be a problem and a cause of concern.

Mitigation

As discussed in the environmental flow section, in times of low flows as a result of drought, the maintenance of the Rivers ecological balance remains paramount and as such restrictions on water usage especially for irrigation will be imposed i.e. irrigation will be halted an issue that may cause tension with the local communities who are beneficiaries and for that matter rigorous awareness creation will be required.

Biological Environment

Water Weeds

Though some areas of the project area are already seasonal and perennial flood plains experiencing the growth of water weeds, the existence of this project could lead to an increase in water weeds especially in the paddies and waterways. This could lead to reduced water flows and provide suitable breeding grounds for vectors such as mosquitoes hence exacerbating health problems such as malaria and bilharzias incidences. It will also result in the reduced efficiency of the system consuming more water than planned.

Mitigation

Proper maintenance procedures especially within the canals and blocks/paddy should be undertaken regularly to ensure that occurrence of water weeds is kept to a minimal.

Marginal Areas Encroachment

The project borders the vast Yala swamp to the south. The proximity of the project close to this important ecosystem could lead to indirect impact through encroachment of the swamp by communities' members who are not going to benefit from the project.

Mitigation

To prevent encroachment of the Yala swamp, a buffer zone should be created around the southern part of the project boundary. The management of the project should also control unplanned outgrowers that might develop when the project is in operation.

Bird Poisoning

Bird poisoning through application of pesticides in the farms might occur as an indirect impact of the project. The wider project area has a rich birdlife and indiscriminate use of agrochemicals might have adverse impacts of the birdlife.

Mitigation

However, this project does not anticipate use of aerial spraying which is more dangerous to bird life than localised application. The impact will be cumulative in nature as the region has other irrigation activities that use aerial spraying in the rice paddies grown.

Farming technologies to be adopted during the operational phase of the project should be environmentally friendly.

- IPM technology should be applied in pest management instead of inorganic chemicals.
- No aerial spraying should be undertaken to control pests

Fisheries Impacts

The project's irrigation and other structures (the diversion weir and the cross-drainage siphons on main canals, and culverts) have a high potential to reduce or prevent fish movement upstream. This will damage the breeding success of scientifically and economically important, globally threatened fishes unique to Nzoia River. The loss of habitat caused by channelisation of the main rivers will affect the lake fishery to some degree, specifically by reduced recruitment of catfish and Tilapia if migration to spawning sites is affected. Additional negative impacts on fish could occur as a result of (i) changed hydrology of the wetlands, (ii) reduced flooded area, and (iii) pesticide runoff in drainage waters.

Social Environment

Resource Use Conflict

Livelihood in the project area is mainly centred on subsistence agriculture and livestock keeping. Conversion of land into predominantly irrigated land will reduce available pasture grounds for families keeping livestock. Livestock keeping particularly in the lower areas of Budalangí is traditional in nature and animals are left to wander freely especially in the areas that flood and along Nzoia River.

Mitigation

To prevent conflict between irrigation farming and livestock keeping, extension services on improved livestock keeping that is more intensive than extensive should be promoted. Practises such as keeping fewer but better breeds that are of more economic benefit should be promoted. In addition, practices such as zero grazing should be introduced to reduce land requirement for livestock keeping.

Water-Borne Diseases

Water retained in the field and canals will create a breeding environment for mosquitoes and snails. This situation will lead to increase in malaria cases and bilharzias.

Mitigation

The control of the water-related diseases will be conducted in a number of ways, some of which are mutually reinforcing. The following measures are proposed to mitigate this impact.

1. Measures aimed at the pathogens: immunization, prophylactic or curative drugs;
2. Introduction of fish in the canals to destroy vector larvae;
3. Undertaking health education, personal protection measures including mosquito nets and mosquito proofing of houses;
4. Management of the irrigation infrastructure;
5. Indoor Residual Spraying
6. Provision of farm toilets in the blocks

Population Migration

Due to minimal economic activities other than subsistence agriculture and livestock keeping, many people have moved from rural settings to urban centres in search of employment. With increased socioeconomic activities and increase income from existence of project there is set to be increase in population of people within the catchments. The effect of this impact will be felt in the health sector through increased rates of HIV/AIDs infection and other diseases that are spread through demographic changes and in environmental sector in terms of degradation.

Managing Population Influx

There are no measures for preventing population influx into the project areas. However NIB and the government in these respective areas should control settlement in fragile areas including wetlands and steep hills through existing legislations such as the Water Act. Another measure to manage influx is through provision of social infrastructure including water and sanitation facilities. Sanitation facilities are particularly critical in the paddy areas as lack of them will result deteriorated water quality. During construction phase of the project, the contractors should have employment policy which gives preference to the local people. By employing the locals, this would discourage population influx to the area.

Safety Hazards

Risks to safety will be in two fronts. The first is during the project implementation phase. During construction of the irrigation infrastructure there is risk of injury to employees undertaking the work as well as community members around the construction activity especially small children. Injury or death could result from

falling into excavated areas, drowning in flooded pit holes and canals as well as injury or death from vehicles, heavy machinery and equipment. The second risk to human safety is during the operational phase. This entails falling into canals leading to injury or death due to drowning. This is an impact more prone to small children and to community members travelling during dark periods (at night) particularly when drunk.

Mitigation

It will be necessary for the project team to ensure that proper working equipment and attire are provided during the construction phase to minimize chances and incidences of death or injury. Similarly, proper warning signage should be appropriately erected especially where there are heavy machines and equipment moving or around excavated areas so as to forewarn any nearby persons of the dangers eminent. Intensive awareness programmes before and during the construction periods on public safety should be undertaken to reduce the chances of this impact manifesting.

Loss of Livelihoods

Current livelihood sources in the area are subsistence farming, livestock keeping and fishing. Increased acreage of irrigation will reduce opportunity for the other existing sources of livelihood in one way or another. Irrigation of 3,500 ha, will reduce acreage available for livestock grazing thus endangering alternative means of livelihood of the locals. This loss could be through reduced amounts of pasture land or negative impacts on fisheries.

Mitigation

Where it occurs displaced people should be compensated and given alternative areas for cultivation to cushion them against shocks such as hunger. The new areas should be developed for them or they should be integrated into the projects associations as they become projects beneficiaries and not losers. Proper management of resources (soil and water) will ensure that aspects such as fisheries will not be adversely affected therefore reducing impact on that source of livelihood. This is important as fish is the key source of protein for not only the area but also as general region. It is critical therefore that this impact is adequately mitigated to safeguard this protein source.

Emergence of Pests and Crop Diseases

Increased acreage of irrigated land will create a more humid environment that may result in an increase of agricultural pests and plant diseases. Change to a more uniform environment on the project areas will favour vigorous species adapted to a wide variety of conditions. Diseases and weeds will spread quickly via the re-use of waste-water and drainage water.

Mitigation

To mitigate against emergence of pests and diseases an incorporation of IPM approaches are proposed. These measures should involve rotational/mixed cropping practices which preserve greater diversity in habitat thus reducing impact of pest and diseases. At the farm level, the agronomist should discourage monocropping. Rice varieties used in this project should be selected from the ones already

introduced in Kenya and allowed by Kenya Plant Health Inspection Services (KEPHIS) in order to avoid new diseases and pests.

Displacement

Displacement is defined here as referring to either physical, economic or cultural displacement (or deprivation). Acquisition of land for irrigation infrastructure, drainage and roads to the project sites will lead to displacement of the services that are provided by the area i.e. housing, grazing, growing fodder, source of domestic water and brick making. It is estimated that about 1,800 plots/parcels of land will be acquired.

Mitigation

The mitigation measures of this impact will be addressed in the Resettlement Action Plan (RAP) for compensating those who are displaced from the areas earmarked for development and construction of water infrastructure. The RAP will take into consideration the investment undertaken in the sites and alternative areas be identified for these people.

Food Security and Subsistence

The presences of Bunyala Irrigation Scheme within the project area will attract potential project beneficiaries to want to grow rice. With higher income as compared to other subsistence crops, subsistence farming might be abandoned in favour for cash flow rice. This trend might affect the production of food crops leading to food insecurity in the project area. While the country agricultural strategy and poverty reduction strategy promote high value crops, subsistence crops still play important role in ensuring food security for the majority of the rural poor. This is an indirect impact that might affect the whole country food security situation, more so because rice is not considered a staple food in Kenya though there is relatively high consumption.

Mitigation

This impact can be mitigated by good land use planning that incorporates rice production and other food crops. Agricultural extension officers should be mobilized to advice farmers on the importance of diversifying crop production and good farm practices such as intercropping, rotational cropping and agro forestry. The project proponents should also embark on encouraging communities to diversify their staple diet so that they do not only rely on traditional food crops as their most important crop even when it has little economic returns. When rice is out of season, irrigation blocks can be cultivated with fast growing seasonal crops which would provide alternative foods for the communities in the area. This will ensure that within the project area there is food available for local consumption.

Movement obstruction due to construction of canals

The creation of canals and feeder canals within the project area will obstruct movement within and without villages and homesteads and make it difficult for movement of people and goods as well as livestock. It will also provide for limitation in accessing social amenities such as schools and medical facilities.

Mitigation

The project design should ensure that existing transportation and communication routes as well as new appropriate ones are adequately covered using culvert. This will ensure that communities and families are not cut off from their friends and relatives. It is also ensure that populations in the area can access social amenities without difficulty. In public areas, culverts should be provided to ease access by people and livestock. In areas where canals and drains will pass near homesteads, culverts should be used.

Child Labour & Low Education Levels

Rice cultivation is a labour intensive activity and in areas of the north where they have been cultivating rice before, most of the members of the households engage in rice cultivation and this could result in drop in school attendance as children provide labour in the paddies. This impact will be more so in poor households that cannot afford to employ additional labour.

Mitigation

Application and strict enforcement of the compulsory free primary education will help to reduce the impact. Also through creating awareness of the importance of education, the beneficiaries should help prevent the impact from occurring. NIB should educate the Irrigation Water Users Association (IWUAs) members to avoid use of children labour during school days. The local administration (chiefs) should enforce of the policy on use of child labour at the project level.

Water and Sanitation Impacts

The return flow from the irrigation paddies will have impact on human health for those villages downstream that use the flood water for domestic uses. This is because the return flows will likely to have significant quantities of pollutants from agrochemicals. This is a cumulative impact as the water from the Nzoia River is already contaminated upstream and may be unfit for human consumption.

Mitigation

NIB in consultation with the local community should provide domestic sources of water during the planning phase of the project. Within every block, there should be provision of safe water supply. The return water flow should pass through buffer zones to enable filtration of agrochemical pollutants to a degree that is fit for domestic use or near the level as required by World Health Organization (WHO) standards².

Human Wildlife Conflict

The presence of warthogs and hippos in the wetlands of Lake Victoria and Yala swamp will cause human wildlife conflict brought about by crop farms that will be most of the dry season green. This is an impact that is already being felt by the residents of the project area. This will be cumulative impact to the area as there is an existing human wildlife conflict.

² World Health Organizations drinking water standards are 0.2 mg/litre for nitrate ion, 1500 mg/litre for potassium or other TDS as a maximum allowable or permissible concentration, optimum pH ranging between 6.5–9.5.

Mitigation

To prevent the hippos from invading the irrigated blocks, a trench should be dug along the southern boundary of the project area. A five metre wide trench is proposed. This measure should be undertaken in consultation with Kenya Wildlife Service (KWS). The design has incorporated a major drain on the southern boundary of the project area. This drainage could also act as a barrier to prevent hippos from crossing over to the irrigated fields.

Noise and Vibration Impacts

Construction activities could result in significant noise impacts so as to impact on general well-being, health and functioning. Large scale infrastructure developments involve the use of heavy equipment (graders, drilling equipment, trucks, blasting equipment, tractors, and excavators) for among others rock blasting, excavation, asphalt mixing plant operations and vehicular movement that emit incessant noise usually harmful to the environment.

Mitigation

This impact is unavoidable and will be mitigated using machinery that minimise noise emissions, construction will be avoided at night.

Land Use Change

The project area is fallow with areas that are submerged with flood water. The change of the area from fallow state to irrigated field will lead to change land. Cumulatively, a total of 3,500 hectares of farmland and fallow areas will be irrigated. This is a permanent impact. However, the area can revert back to its status after decommissioning of the project but it will take a long period of time before the rejuvenation.

Mitigation

This impact is unavoidable and can only be compensated through allocating those who will be displaced from their farms and leaving part of the project area fallow for grazing and firewood supply.

Cumulative Impacts

Water abstraction from the Nzoia River for the scheme will marginally reduce the net water volume available in the River (because of consumptive use by crops). In itself, this will not affect downstream water users significantly. However, when combined with other existing and planned water abstractions from the River Nzoia, it will contribute to significant impacts on overall water availability in the sub-basin in dry years.

Abstraction of water from the Nzoia River combined with other irrigation schemes within the same River will cumulatively impact on the hydrology of the River especially downstream and an Environmental Flow Analysis (EFA) is required in order to determine the overall of all the irrigation projects on the Nzoia River and its capacity as a tributary to the Lake Victoria Basin.

There are a number of irrigation schemes in the project districts including Bunyala Rice Scheme, Rwambwa Mudembi, Nahasyongo Muluwa, Muuri, Neboka, Bubasi,

Munaka, Yala Swamp, Syamungu and Busagwa. In the project area the major existing irrigation scheme is the Bunyala irrigation scheme (280ha) which is under the management of the NIB. Altogether these schemes are currently cultivating about 700 acres of rice but at different times of the year.

In terms of water use by the communities along River Nzoia, abstraction of water for irrigation combined with other on-going abstraction projects may cause adverse impacts and conflicts by communities who depend on the water for domestic purposes. Especially the populations living downstream whose livelihoods may be affected by dam-induced alterations of river flows especially during the dry season.

Mitigation-Maintaining 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 valued features of the ecosystem. (McCartney et al. 2008). **Table 5** in this report shows the water balance and environmental flows and water availability after meeting the requirements of Phase I &II as well as the environmental flows. The highest irrigation water requirements is in July and it amounts to 4.025m³/s and 2.310m³/s for phase I and II respectively, while the environmental flows (0.3 f Q₉₅) amounts to 8.21m³/s which leaves 43.72 m³/s as surplus in the river in that month.

1.1.1 Environmental Monitoring Plan

An Environmental Mitigation and Monitoring Plan has been prepared for this project complete with the key indicators and cost for monitoring. The plan integrates the Irrigation Water Users Association and local communities as part of the monitoring and a strategy for capacity building.

1.1.2 Implementation and Management

The implementing agency for this project is National Irrigation Board (NIB) which will establish a Project Management Unit (PMU) specifically for this project. The PMU will include full time staff from NIB based at the project site level and will include specialists in environment, social and community development, engineers, agronomists etc. Key community representatives, members of IWUA, staff from key ministries with responsibilities in ensuring the effective implementation of the ESMP will also form part of the PMU. The executing agency will conduct periodic monitoring while key institutions like Water Resources Management Authority (WRMA), National Environment Management Agency (NEMA) will equally conduct routine monitoring as provided for by the legal framework.

1.1.3 Capacity Building

The capacity of the relevant stakeholders responsible for implementing the recommendations in the ESMP will be strengthened through field trainings, short courses, workshops and seminars among others. Members of the IWUA will be trained on Participatory Irrigation Management (PIM). Areas requiring capacity building for the different stakeholders is contained later sections of this report and includes an indicative budget for the same.

1.1.4 Recommendations and Conclusion

There is a need for NIB to establish a PMU with a wide representation from the relevant line ministries as identified in this study. The PMU should have representation from the implementing agency (NIB) which will serve as the secretariat, Ministry of Public Health and Sanitation to advice on management of health impacts, WRMA to advice on water resources, Ministry of Agriculture to provide advice on IPM among other relevant stakeholders. NIB should also establish project office in Bunyala that will have a community liaison officer to respond to community issues as they arise and be the bridge between the relevant government agencies that are responsible for the environmental and social management plan.

The project beneficiaries (IWUAs) should be trained in good farming husbandry and pest management especially in the area of Integrated Pest Management (IPM). A refresher training program should be introduced throughout the whole scheme and extension farms on the adequate application of fertilizer use per hectare of land and during what conditions should it be undertaken throughout the project. The types and amounts of pesticides should also be part of this training. This training should be a hands-on approach that can be introduced at farmer's field schools (FFS). To prevent against water-logging in the scheme farms, the farmers should be trained in efficient irrigation water management.

At the project level, Ministry of Water and Irrigation through NIB should be equipped to have the capacity to undertake sample analysis of parameters identified in the monitoring plan. These should include soil and water quality analysis. The project staff should also be trained in monitoring of the identified impacts to enable them monitor the project performance.

Ministry of Environment and NEMA should be equipped with technical and institutional capacity in the field of wetland management. NEMA needs to develop sector specific guidelines that will provide environmental guidelines for the development of the agricultural sector. NEMA's capacity in monitoring of environmental indicators should also be strengthened to effectively monitor parameters.

At the district level, the environment officers should be trained and the department strengthened to work closely with NEMA. The training should cover environmental assessment, monitoring and review of assessments and management plans.

The civil works construction firm should use the local communities labour to construct, rehabilitate the scheme's canals, unit and line gates. This way, community members will learn to operate and maintain the infrastructure.

It is advisable that before the project commencement, there is urgent need to rehabilitate the existing dyke or building of a new dyke that will be necessary to protect the propose project infrastructure from floods.

To prevent water stagnation, the designers should ensure the canals gradient is enhanced to increase water flow. Moreover the main canal should have emergency spillways.

Discharge from the irrigation farms should pass through a wetland to enable filtration of agrochemicals washed from the farms. For the southern drainage, discharging into Yala swamp will ensure that the swamp filters the chemicals. For the right drainage, discharging spent irrigation water into Nzoia River without filtering will create eutrophication environment into Lake Victoria. In this regard, the project will create an artificial wetland in areas where there is discharge into Nzoia River. To avoid flooding upstream of Nzoia River, the weir should have overflow spillway.

CONCLUSION

The management of water application systems as well as the suitability of related agronomic practices has a dramatic influence on the environmental impact of irrigated agriculture. Constraints in the water delivery systems (e.g., continuous versus on-demand water supply), extremely low water quality of the irrigation water supply, and limitations to investment on improved technologies exacerbate the environmental damage derived from irrigation and limit the options available to farmers for mitigating the problem. Nevertheless, improved management and technologies are the main tools available to ensure the sustainability and productivity of irrigation in Nzoia Scheme and its extension farms.

The general problems that affect irrigated areas are water-logging, salinization, soil erosion, downstream degradation of water quality by salts, agro-chemicals and toxic leachates. All these are a serious environmental problem.

In Nzoia Irrigation Scheme, the main attributes associated with poor irrigation outputs are due to high salinity levels, water loss, water logging, run-off from agricultural chemicals and soil erosion. Other related impacts are contamination of groundwater sources and human related impacts such as public health impacts caused by water-borne diseases-- malaria, cholera, typhoid and amoebiasis.

Water-logging and salinization impacts can be reduced by investments in education and management capacities, drainage improvements and soil stability works are relevant for the case of Nzoia Irrigation Scheme and its extension farms.

The impact of agricultural run-off on water quality is not well documented in Kenya and as result data on water pollution is limited or non-existent. Furthermore, available data is mostly aggregated, not distinguishing the relative proportion of point and non-point sources. Therefore, the water quality databases found are often of little value in pollution management at the river basin scale, and are not useful in determining the impacts of specific agricultural practices (irrigation) in relation to other types of anthropogenic impacts.

Public health impacts in irrigation practices are mainly associated with polluted water as the major cause of water borne diseases. Surface runoff, stagnant waters and improperly designed rural sanitary facilities contribute to this problem. The use of untreated (or poorly treated) human wastewater throughout Nzoia Irrigation Scheme contributes to direct contamination of food produce such as vegetables. Furthermore, in Nzoia and its immediate environs there is little or no treatment of

municipal sewage resulting in direct sewage wastewater flows into River Nzoia and its tributaries. To solve such issues education on the use of proper sanitary facilities and adequate waste water treatment facilities upriver have to be introduced to alleviate the health related problems associated with irrigation water.

Finally, agriculture development has to go on to feed the population that keeps on growing while maintaining the natural resource base that supports agronomy. There is need to balance between human activities and the resource base.

Implementation of the proposed Lower Nzoia Irrigation Scheme Phase 1 is expected to bring approximately 4,043 ha of land under irrigation and benefit more than 2,100 small scale farmers through improved production of food and provision of incomes. It is expected that an average household will gain approximately Kshs. 392,000 from irrigated farming annually. The increase of the irrigated area from the existing 705 hectares to 4043 hectares will be a major boost to the Kenyan economy whose target is to increase the area under irrigation by 40,000 hectares annually. In addition to irrigation infrastructure, the project will benefit from support in post harvest handling and marketing infrastructure and support for management investments which are covered under components 2, 3 and 4 respectively. The project's incremental benefits are expected to be more than Kshs 1.27 billion once production stabilizes. The project is however, expected to cost more than Kshs. 4.4 Billion. Financially, the project is found to be viable resulting to acceptable discount rates and positive cash flows that will guarantee its sustainability. Further, expected household incomes are enough for the farmers to contribute towards operation and maintenance costs further guaranteeing sustainability of the project.

Economically, the project would result to positive externalities in the country as economic benefits are more than the economic costs of the project. Additionally, the provision of food to the country, creation of employment opportunities and generation of foreign exchange from tradable commodities will positively contribute towards the country's gross domestic product GDP and Balance of Payments (BOP). Compared to these benefits, the major negative externality relate to the potential pollution of the soil and water resources following use of agrochemicals and the alteration of natural flora and fauna as a result of farming activities. However, a sound social and environmental management plan has been developed against these negative externalities.

Based on the direct and indirect project benefits, a No project option is not a viable alternative for this project. Considering the fact the potential project impacts can be avoided or mitigate effectively, the project benefits outweigh the costs in terms of adverse impacts. Based on the above considered factors, a "no-project scenario" is not an attractive alternative.

TABLE OF CONTENT

1	EXECUTIVE SUMMARY	2
	<i>Project Rationale</i>	<i>2</i>
	<i>Project Objective</i>	<i>2</i>
	<i>Project Design and Benefits</i>	<i>2</i>
	<i>Project Cost</i>	<i>3</i>
	<i>Environmental and Social Impact Assessment Study Objectives</i>	<i>3</i>
	<i>Potential Adverse Impacts.....</i>	<i>4</i>
	<i>Physical Environment.....</i>	<i>4</i>
	<i>Biological Environment</i>	<i>9</i>
	<i>Social Environment.....</i>	<i>10</i>
	<i>1.1.1 Environmental Monitoring Plan</i>	<i>16</i>
	<i>1.1.2 Implementation and Management</i>	<i>16</i>
	<i>1.1.3 Capacity Building</i>	<i>16</i>
	<i>1.1.4 Recommendations and Conclusion</i>	<i>17</i>
	<i>Conclusion.....</i>	<i>18</i>
	TABLE OF CONTENT.....	20
	LIST OF TABLES.....	24
	LIST OF FIGURES	24
	ACRONYMS AND ABBREVIATIONS	25
2	INTRODUCTION.....	28
2.1	Project Need	28
2.2	Historical Background/Existing Conditions.....	29
2.2.1	<i>Project Details.....</i>	<i>29</i>
2.3	Study Objectives	33
3	STUDY SCOPE AND METHODOLOGY	34
3.1	Study Scope.....	34
3.2	Study Methodology	36
3.2.1	<i>Baseline Assessment.....</i>	<i>36</i>
3.2.2	<i>Project Alternatives</i>	<i>37</i>
3.2.3	<i>Public Consultation</i>	<i>37</i>
3.2.4	<i>Impact Prediction and Evaluation</i>	<i>38</i>
3.2.5	<i>Environmental and Social Management Plan</i>	<i>39</i>
4	PROJECT DESCRIPTION.....	41
4.1	Projects Activities	42
4.1.1	<i>Irrigation Method.....</i>	<i>42</i>
4.1.2	<i>Drainage System</i>	<i>42</i>
4.1.3	<i>Improvement of the Existing Roads</i>	<i>43</i>
4.2	Project Design	43
4.2.1	<i>Head Works.....</i>	<i>43</i>
4.2.2	<i>Sedimentation Basin</i>	<i>44</i>
4.2.3	<i>Main Canal</i>	<i>44</i>
4.2.4	<i>Secondary Canals.....</i>	<i>45</i>
4.2.5	<i>Tertiary Canals/Water Courses</i>	<i>45</i>
4.2.6	<i>Feeder Canals</i>	<i>45</i>
4.2.7	<i>Drainage System.....</i>	<i>45</i>
4.2.8	<i>Access Roads</i>	<i>45</i>
4.2.9	<i>Flood Control and Protection Works</i>	<i>45</i>
4.2.10	<i>Other Structures.....</i>	<i>45</i>
4.2.11	<i>Detailed Design Works</i>	<i>47</i>
4.2.12	<i>Construction Works.....</i>	<i>47</i>
4.2.13	<i>The Implementation Period for the Project</i>	<i>47</i>
4.3	Construction Equipment	47
4.4	Irrigation and Drainage Water Requirements.....	48
4.5	Cropping Pattern and households.....	2
4.6	Project Implementation and Management	2

4.7	Project Beneficiaries	2
4.8	Cost Estimate	5
5	PROJECT ALTERNATIVES	7
5.1	Alternative Technology	7
5.2	Water Supply Option for irrigation	7
5.3	Alternative Project Site	7
5.4	Alternative Scale and Design.....	8
5.5	No Project Alternative	8
6	PROJECT AREA DESCRIPTION	9
6.1	Physical Environment.....	9
6.1.1	<i>Location</i>	9
6.1.2	<i>Hydrology of Lower Nzoia</i>	10
6.1.3	<i>Water Rights</i>	14
6.1.4	<i>Climate and Meteorology</i>	14
6.1.5	<i>Drainage</i>	15
6.1.6	<i>Geology and Soils</i>	16
6.1.7	<i>Land Tenure and Use</i>	19
6.2	Biological Environment.....	21
6.2.1	<i>Flora</i>	21
6.2.2	<i>Fauna</i>	23
6.3	Socio-Economic Environment	24
6.3.1	<i>Population and Demography</i>	24
6.3.2	<i>Settlement Patterns</i>	25
6.3.3	<i>Land Tenure System</i>	25
6.3.4	<i>Livelihoods</i>	27
6.3.5	<i>Health</i>	33
6.3.6	<i>Transportation and Communication</i>	34
6.3.7	<i>Energy and Domestic Water Sources</i>	35
6.3.8	<i>Water Access and Sanitation</i>	36
6.3.9	<i>Education and Literacy levels</i>	37
6.3.10	<i>Gender and Inequality</i>	37
6.3.11	<i>Culture</i>	38
6.3.12	<i>Security</i>	38
6.3.13	<i>Poverty</i>	38
6.3.14	<i>Income</i>	39
6.3.15	<i>Challenges and needs in the project area</i>	39
6.4	Sensitive Ecosystem.....	41
6.4.1	<i>Yala Swamp</i>	41
6.4.2	<i>Nzoia River</i>	41
6.5	Environmental and Social Trends.....	41
6.5.1	<i>Poverty</i>	41
6.5.2	<i>Population Increase</i>	43
6.5.3	<i>Soil Erosion</i>	43
6.5.4	<i>Deforestation</i>	43
6.5.5	<i>Floods</i>	44
6.5.6	<i>Irrigation</i>	45
6.5.7	<i>Human Wildlife Conflict</i>	45
6.5.8	<i>Farming in Flooded Areas</i>	45
7	POLICY, LEGAL AND INSTITUTIONAL FRAMEWORK	46
7.1	Legislative Framework	46
7.2	The Constitution of Kenya	46
7.3	Environmental Management and Coordination Act, EMCA 1999	46
7.4	Water Act	48
7.5	Irrigation Act (Cap 347).....	49
7.6	Agriculture Act.....	49
7.7	The Public Health Act (Cap 242).....	49

7.8	The Physical Planning Act.....	50
7.9	Land Act 2012	50
7.10	Occupational Health and Safety Act, 2007	50
7.11	The Wildlife Conservation and Management Act, Cap 376	52
7.12	Policy Framework	53
7.12.1	<i>Vision 2030</i>	53
7.12.2	<i>Poverty Reduction Strategy Paper</i>	54
7.12.3	<i>Irrigation Policy</i>	54
7.12.4	<i>Draft Wetland Policy</i>	55
7.12.5	<i>National Food Policy</i>	55
7.13	International Regulations.....	56
7.13.1	<i>World Bank Safeguard Policies</i>	56
7.13.2	<i>Environmental Assessment (OP 4.01)</i>	56
7.13.3	<i>Natural Habitats (OP 4.04)</i>	57
7.13.4	<i>Forests (OP 4.36)</i>	58
7.13.5	<i>Pest Management (OP 4.09)</i>	58
7.13.6	<i>Physical Cultural Resources (OP 4.11)</i>	59
7.13.7	<i>Projects on International Waterways (OP 7.50)</i>	60
7.13.8	<i>Involuntary Resettlement (OP 4.12)</i>	60
7.13.9	<i>Projects in Disputed Areas (OP 7.60)</i>	62
7.13.10	<i>Indigenous Peoples (OP 4.10)</i>	62
7.14	International Conventions.....	63
7.14.1	<i>United Nations Convention on Biological Diversity</i>	63
7.14.2	<i>Ramsar Convention on Wetlands</i>	64
7.14.3	<i>Convention on the Conservation of Migratory Species</i>	64
7.14.4	<i>EAC Protocol on Environment</i>	64
7.15	Institutional Arrangements.....	65
7.15.1	<i>National Environment Management Authority</i>	65
7.15.2	<i>National Irrigation Board</i>	65
7.15.3	<i>Ministry of Water and Irrigation</i>	65
7.15.4	<i>Ministry of Public Health and Sanitation</i>	65
7.15.5	<i>Ministry of Agriculture</i>	66
7.15.6	<i>Water Resources Management Authority</i>	66
7.15.7	<i>Ministry of Livestock and Fisheries</i>	66
7.15.8	<i>Nile Basin Initiative</i>	67
8	potential ENVIRONMENTAL & SOCIAL IMPACTS & proposed MITIGATION	
	measures	71
8.1	Beneficial Impacts	71
8.1.1	<i>Physical Impacts</i>	71
8.1.2	<i>Ecological Impacts</i>	71
8.1.3	<i>Socio-Economic Impacts</i>	72
8.2	Potential Adverse Impacts.....	75
8.2.1	<i>Physical Environment</i>	75
8.2.2	<i>Biological Environment</i>	86
8.2.3	<i>Social Environment</i>	87
9	PROJECT ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN	101
9.1	ESMP Objectives	101
9.2	ESMP Implementation	101
9.2.1	<i>World Bank</i>	102
9.2.2	<i>National Irrigation Board</i>	102
9.2.3	<i>Ministry of Agriculture</i>	103
9.2.4	<i>National Environment Management Authority</i>	103
9.2.5	<i>Project Beneficiaries</i>	103
9.2.6	<i>Water Resources Management Authority</i>	104
9.2.7	<i>Contractors</i>	104
9.2.8	<i>Ministry of Health</i>	104

9.2.9	Ministry of Education	104
10	MONITORING PLAN	116
10.1	Monitoring Schedule	118
11	PROJECTS COST BENEFIT ANALYSIS	123
11.1	Financial and Economic Evaluation	123
11.1.1	Methodology for Financial and Economic Analysis	124
11.1.2	Current Agricultural Production and Revenues	125
11.1.3	Proposed Interventions and Project Components	127
11.1.4	Project Cost	127
11.1.5	Estimation of Project Benefits	128
11.1.6	Crop Budget, Prices and Yields	128
11.1.7	Crop Budgets	128
11.1.8	Expected Agricultural benefits	129
11.1.9	Incremental benefits	130
11.1.10	Project Evaluation	130
11.1.11	Financial Analysis	131
11.1.12	Economic Analysis	132
11.1.13	Project Economic Cost	132
11.1.14	Sensitivity and Risk Analysis	133
11.1.15	Operation, Maintenance and Project Sustainability	134
11.1.16	Conclusions and Recommendations	135
12	EMERGENCY RESPONSE PLAN	137
12.1	Early Warning System	137
12.2	Roles and Responsibilities	137
12.3	Evacuation Plan	138
12.4	Water Contamination	138
13	PUBLIC consultation	147
13.1	Stakeholder Mapping	147
13.2	Stakeholder Identification	147
13.3	Stakeholder Consultation	147
13.3.1	Focus Group Meetings	147
13.4	Issues and Concerns	148
14	RECOMMENDATIONS AND CONCLUSION	149
14.1	Recommendations	149
14.2	Conclusion	150
ANNEXES	152
A	List of Participants	152
B	Issues and Response Report	182
C	Questionnaire	187
D	Cultural Sites and Location	188
E	Soil Codes	190
REFERENCES	192

LIST OF TABLES

Table 1: Details of Irrigable areas	31
Table 2: Environmental Impact Matrix.....	35
Table 3: Proposed Implementation Schedule	47
Table 4. Diversion Water Requirement	Error! Bookmark not defined.
Table 5: Comparative Analysis of alternative project technologies.....	7
Table 6: Irrigable administrative units.....	10
Table 7. Table Nzoia River Water quality analysis	11
Table 8: Monthly reliable flows (1950 to 2004) for RGS 1EF01	Error! Bookmark not defined.
Table 9: Ecosystem types around the project site.....	23
Table 10: National Ecosystem type	23
Table 11: Common Birds of the Yala Swamp and its Environs.....	24
Table 12: Population in the project area	Error! Bookmark not defined.
Table 13: Housing building materials in the project districts	25
Table 14: Sectoral contribution to Household incomes	29
Table 15: Cropping calendar	31
Table 16: Domestic Livestock in the area	31
Table 17. Length of roads in Siaya and Bunyala districts	35
Table 18: Education institutions and literacy levels in project districts	37
Table 19: Summary of the Operational Policies that will be triggered by the project.....	63
Table 20: Institutional Capacity of ESMP Implementing Agencies	68
Table 21: EMP cost break down per year	Error! Bookmark not defined.
Table 22: Summary of the construction Costs (US\$) for Lower Nzoia.....	123
Table 23: Total Project Costs for Option I (Phase I)	Error! Bookmark not defined.
Table 24: Emergency Response Plan Matrix	139

LIST OF FIGURES

Figure 1 Location of project area	32
Figure 2: Nzoia Environmental Impacts Network.....	38
Figure 3: Project area location	9
Figure 4: Nzoia River discharge	12
Figure 5: Hydrological map of the area.....	14
Figure 6: Soil types in the project area	18
Figure 7. Landcover of Nzoia catchment.	20
Figure 8: Ecosystem types	22
Figure 9: Land ownership amongst the respondents	26
Figure 10: Average land ownership per household.....	26
Figure 11: Percentage of population with land ownership documents	27
Figure 12. Livelihoods in the project area from household survey	27
Figure 13: Crops grown in the area.....	28
Figure 14: Average monthly income per Household by economic activity	29
Figure 15: Percentage of households planting the crop	30
Figure 16: Percentage of households using manure/fertilizer in the project sub-locations.....	30
Figure 17: Reasons for unemployment by gender	33
Figure 18: Disease prevalence in the area.....	34
Figure 19: Sources of Domestic energy from household survey	35
Figure 20: Sources of domestic water in the project area.	36
Figure 21: Literacy Levels in the project area	37
Figure 22: Average monthly income per Household by economic activity	39
Figure 23: Prioritization of needs in the project area	40
Figure 24: Yala swamp location relative to the project area	41
Figure 25: Perceived challenges and needs the household survey.....	42
Figure 26 Variation in discharge at Rwambwa station	44

ACRONYMS AND ABBREVIATIONS

ACZ	Agro-climatic zones
AIDS	Acquired Immune Deficiency Syndrome
AMSL	Above Mean Sea Level
ASCV	Agricultural support and Chain Value
ASDS	Agricultural Sector Development Strategy
BC	Benefit to Cost (BC)
BCR	Benefit Cost Ratio (BCR)
BOP	Balance of Payments
CAACs	Catchment Area Advisory Committees (CAACs).
CAACs	Catchment Area Advisory Committees
CAADP	Comprehensive Africa Agriculture Development Program
CBA	Cost Benefit Analysis
CBS	Central Bureau of Statistic
CDA	Coast Development Authority
CDD	Community Driven Development
CF	Conversion Factors (CF)
CoK	Constitution of Kenya
CSO	Civil Society Organizations
DDP	District Development Plan
DEC	District Environmental Committees
DOHS	Directorate of Occupational Health and Safety (DOHS)
DOHS	Directorate of Occupational Health and Safety
EA	Executing Agency ()
EAs	Environmental Assessments
ECOC	Economic Cost of Capital (ECOC)
EFA	Environmental Flow Analysis (EFA)
EHS	Environmental, Health and Safety
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return (EIRR)
EIRR	Economic Internal Rate of Return
EMCA	Environmental Management and Coordination Act
EMP	Environmental Management Plan
ENPV	Economic Net Present Value (ENPV)
EO	Environmental Officer
ERP	Emergency Response Plan
ERR	Economic Rate of Return (ERR)
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Management Plan
FAO	Food and Agricultural Organization
FFS	Farmer's Field Schools
FM	Financial Management
FS	Feasibility Study
GDP	Gross Domestic Product
GIS	Geographical Information System
GIZ	German Agency for International
GOK	Government of Kenya
Ha	Hectares
HCDA	Horticultural Crops Development Authority
HIV	Human Immunodeficiency Virus
HVC	High Value Crops
I & DI	Irrigation and Drainage Infrastructure
I&AP	Interested and Affected Parties

ICT	Information and Communication Technologies
IE	Impact Evaluation
IF	Investment Framework
IIM	Impact Identification Matrix
IKS	Indigenous Knowledge Systems
ILRI	International Livestock Reserch Institute
IPM	Integrated Pest Management
IPMP	Integrated Pest Management Plan
ITCZ	Inter-tropical convergence zone
ITCZ	Inter-Tropical Convergence Zone
IWUAs	Irrigation Water Users Associations
KARI	Kenya Agricultural Research Institute
KEPHIS	Kenya Plant Health Inspectorate Services
KFS	Kenya Forest Service
KFSSG	Kenya Food Security Steering Group
KfW	German Reconstruction Credit Institute (Kreditanstalt für Wiederaufbau)
KIHBS	Kenya Integrated Household Budget Survey
KMD	Kenya Metropolitan Department
KNRMP	Kenya Natural Resources Management Project
Ksh	Kenyan Shilling
KWS	Kenya Wildlife Services
KWSIP	Kenya Water Sector Investment Program
LIRSSU	Legal and Institutional Reforms Support Sub-Unit
LNIDP	Lower Nzoia Irrigation Development Project
M&E	Monitoring and Evaluation
MCM	Million Cubic Meters
MDGs	Millennium Development Goals
MEMR	Ministry of Environment and Mineral Resources
MoA	Ministry of Agriculture
MoE	Ministry of Education
MOF	Ministry of Finance
MoFW	Ministry of Forestry and Wildlife
MoH	Ministry of Health
MORDA	Ministry of Regional Development Authorities
MPND	Ministry of Planning and National Development
MSDS	Materials Safety Data Sheets
MUV	Manufacturers Unit Value Index
MW	Megawatt
MWI	Ministry of Water and Irrigation
NALEP	National Agriculture and Livestock Extension Programme
NCPB	National Cereals and Produce Board
NCPB	National Cereals and Produce Board
NDOC	National Disaster Operations Centre
NEMA	National Environment Management Authority
NET	National Environmental Tribunal
NGO	Non-Governmental Organization
NIB	National Irrigation Board
NMK	National Museums of Kenya
NPV	Net Present Value (NPV).
NRM	Natural Resources Management Project
NRS	National Rice Strategy
NWRMS	National Water Resource Management Strategy
O&M	Operations and Maintenance
OO&P	Otieno Odongo and Partners

OOP	Office of the President
OP	Operational Policy
OP/BP	Operational Policy/Bank Policy
OSHA	Occupational Safety and Health Act
OSHA	Occupational Safety and Health Act
PAD	Project Appraisal Document
PCC	Public Complaints Committee
PCR	Physical and Cultural Resources Plan,
PHO	Public Health Officer
PIC	Public Information Center
PMP	Pesticide Management Plan
PMU	Project Management Unit
PPE	Personal Protective Equipment
PRA	Participatory Rural Appraisal
PRSP	Poverty Reduction Strategy Paper
PS	Permanent Secretary
RAP	Resettlement Action Plan
RAP	Resettlement Action Plan
SEA	Strategic Environmental Assessment
SERC	Standards and Enforcement Review Committee
TOR	Terms of Reference
UNCBD	United Nations Convention of Biological Diversity
UNEP	United Nations Environment Programme
US\$	United States Dollars
VCT	Voluntary Counselling and Testing
VOC	Volatile Organic Compounds
WASREB	Water Services Regulatory Board
WaSSIP	Water and Sanitation Service Improvement Project
WB	World Bank
WHO	World Health Organization
WIS	Water Information System
WKDDP	Western Kenya Community Driven Development Project
WKIEMP	Community Development and Floods Mitigation Project
WRMA	Water Resources Management Authority
WRUA	Water Resources Users Association
WSB	Water Services Board
WSCRIP	Water Security and Climate Resilience Project
WSP	Water Services Provider
WSTF	Water Services Trust Fund
WUAs	Water Users Associations

2 INTRODUCTION

2.1 PROJECT NEED

The Government of Kenya (GOK), with its predominantly rural population, relies heavily on the agricultural sector for achieving a steady economic growth for its people. The sector accounts for over 65% of total Kenya exports, provides 18% of formal employment and more than 70% of informal employment in the rural areas. Over 60% of the national income is also from this sector. During the past several years, the sector has consistently registered the highest contribution to economic growth when compared to other sectors and is expected to continue carrying the burden of ensuring sustainable economic growth in the country for the foreseeable future. This role is demonstrated by the corresponding growth of the Gross Domestic Product (GDP) which has been on a growth path since 2002. The GDP was 5.8% in 2005, 6.1 % in 2006, 7% in 2007 1.5% in 2008, 2.6% in 2009 and 5.6% in 2010 (Source: 2011 Economic Survey Report). Due to the recent disturbances in the country, the GDP is projected to reduce to 4.5%. Further, it has been established that there is a strong correlation between growth in the agricultural sector and that in GDP.

With 90,000 hectares of land (1.2 percent of cropland, and 17 percent of potential) benefiting from irrigation, and with close to 26m hectares of agricultural land depending on highly unpredictable rainfall, there is a need to put more agricultural land to irrigation. Climate variability has a significant impact on the vulnerability of both smallholder farmers and the national economy. Climate variability and the inability of Government of Kenya (GoK) to deal effectively with its impacts jeopardize stable economic growth and provide a volatile environment for successful implementation of macroeconomic reforms and better governance of public resources.

Kenya has a drainage potential of 600,000 ha, and irrigation potential of 539,000 ha. Out of the 90,000 ha under irrigation in Kenya, about 13% is gazetted as public irrigation. Kenya's public irrigation assets are managed by the National Irrigation Board (NIB). The NIB is a semi-autonomous body, established under the Irrigation Act of 1966, and is responsible for planning, construction, setting and managing national irrigation schemes. At present, it operates 6 schemes: Mwea (6,000ha), Ahero (900ha), West Kano (900ha), Bunyala (300ha), Perkerra (500ha) and Hola (850ha). Many of these schemes are irrigated through pumps, which raises concerns about their sustainability in view of farmer-led management.

The proposed Lower Nzoia Irrigation Development Project (LNIDP) is to be located on the lower end of River Nzoia. Nzoia River Basin lies between latitudes 00^o 02' N; 01' 14'N and longitudes 33^o 54'E; 35^o 35'E. The River flows through the Rift Valley, Western and Nyanza Provinces. The main water sources for irrigation within the study area will come from the Nzoia River. From the water availability point of view, the upper and middle Nzoia catchment would not support irrigation development without a dam being put in place.

The study area is thus confined to the Lower Nzoia Basin where water resources assessment shows that there is enough base flow to support the irrigation project.

Several studies have been carried out in the project area to primarily to map out the potential development of Lake Basin inclusive of the Nzoia Basin.

This interest stems from the previous studies in the basin and that are now earmarked as a flagship projects under the economic pillar for the Kenya's development vision by year 2030 under Vision 2030. Irrigation will not only reduce risks in agricultural production in the area but also provide an opportunity for a commercial agricultural development for the poor small holder farmers. The study area is located in the Lower Nzoia Basin in Nyanza and Western Provinces of Kenya. The previous studies undertaken by NIB divided the basin into three major catchment areas, the Lower, the Middle and the Upper Nzoia Basins respectively.

2.2 HISTORICAL BACKGROUND/EXISTING CONDITIONS

The proponent, National Irrigation Board (NIB), has proposed the development of Lower Nzoia Irrigation Development Project (LNIDP). This project entails the development of Lower Nzoia Irrigation Development Project which includes in the project area the existing Bunyala Irrigation Scheme. This Environmental and Social Impact Assessment (ESIA) report was commissioned by NIB and was prepared in accordance with the Environmental Impact Assessment and Audit Regulations 2003 and the World Bank Procedures OP 4.01-Environmental Assessment.

The NIB managed irrigation scheme in the study area is the Bunyala Irrigation Scheme which is located in Western Province, Busia District and covers an area of 270 ha. This new project proposes to include and expand around the Bunyala Irrigation Scheme area by 3,500ha. Other existing irrigation schemes that have come up within the area include Mundebi Irrigation Scheme, which is under the joint management of NIB and Plan International. A smallholder irrigation scheme called Anyiko Irrigation scheme also exists around the project area.

2.2.1 Project Details

The Lower Nzoia Irrigation Development Project Phase 1 is a flagship project of the Kenya Agricultural Sector Development Strategy (ASDS). Located in Western Kenya, not far from the town of Kisumu, this public irrigation scheme would derive its water from the Nzoia River, which flows into Lake Victoria a bit further downstream.

Phase 1 of the Lower Nzoia Irrigation Development Project is located on the left bank of the river; GoK also plans to develop the right bank of the river (referred to as Phase 2) using the same intake infrastructure. Feasibility and design work for Phase 1 have been funded under the World Bank's Natural Resources Management (NRM) Project. Phase 1 would have a gross command area of over 5,700 hectares and a net command of 4,000 hectares, including 2,500 hectares for cash crops, notably paddy, tomato and fruit. The existing Bunyala Pump Irrigation Scheme that has a net irrigable area of 213.7 hectares is included within the scheme area. The technology is gravity canal irrigation, with furrow or basin irrigation at farmers' plot levels, depending on the crops. The Phase 1 sub-project will consist of the following activities:

(a) Irrigation and drainage infrastructure, including river intake facilities; network of canals and drains; flow control structures and facilities (most of which are being carried out as part of the on-going World Bank-financed Western Kenya Community Driven Development and Flood Mitigation Project; farm road network and passages and technical buildings; and other ancillary facilities;

(b) Agriculture and value chain enhancement, including supporting the implementation of the agricultural development plan, providing assistance to farmers and other stakeholders engaged in market-oriented agriculture through an integrated approach, and providing marketing infrastructure; and

(c) Participatory irrigation management, including defining and implementing appropriate systems and processes for management, operation and maintenance of irrigation-related functions with involvement of Irrigation Water Users Associations (IWUAs) in order to contribute to investment sustainability and performance.

(d) Sub-Project management, including cost of the Environmental and Social Management Plan (ESMP), establishment and implementation of a monitoring and evaluation system that contains performance indicators, and construction supervision.

The estimated cost of the sub-project – inclusive of the above activities – is US\$ 44.6 million, US\$ 20m of which **KfW** will co-finance. The implementation period of Phase 1 is expected to be four years. It would be carried out in stages in order to allow benefits to start early in the implementation period. The works would start with the head works and main canal.

Lower Nzoia Irrigation Development Project is planned in the Lower Nzoia Basin that covers Siaya and Bunyala Districts. The area is project area lies within latitude 0° 04'N and 0° 11'S and longitude 33° 57'E and 34° 14'E. On the figure 1 below, the project area is indicated as Area 1b with colour code pink. The proposed site for the intake is also shown on the figure.

The project area is located in the Busia and Siaya Counties in the western part of the country. Previous studies have divided the Nzoia River Basin into three major parts, the Lower, Middle and Upper Nzoia Basins. The basin has four (4) major sub-catchment areas namely 1B-Upper Nzoia, 1C-Kipkarren, 1D-Middle Nzoia Kuywa, and 1E-Lower Nzoia.

- The Upper Nzoia has an approximate coverage of 5,446 km². It covers the Marakwet, Keiyo, West Pokot, Trans Nzoia, western parts of Mt. Elgon and the northern parts of Uasin Gishu and Lugari districts.
- The Kipkarren catchment (1C) drains the western parts of Keiyo, Uasin Gishu, northern parts of Nandi and southern parts of Lugari districts. It covers an approximate area of 3,095 km².

- The Middle Nzoia-Kuywa catchment (1D) drains an area of approximately 2,083 km², which covers the middle north to south parts of Mt Elgon, northern part of Kakamega and middle parts of Bungoma districts.
- The Lower Nzoia catchment (1E), with an area of 2,593km², is in the lower most parts of the Nzoia Basin. It covers the southern and middle Kakamega, most parts of Siaya and the southern tip of Busia districts. This is the Basin will include this project area.

The scheme is expected to expand the irrigated land over an area of 3,500ha. The general study area in the Lower Nzoia Irrigation Development option is restricted to the Lower Nzoia Basin. The design survey has identified the irrigation area on the eastern side of Nzoia River (the ESIA area) as tabulated in **table 2 below**:

Table 2: Details of Irrigable areas

Description of Area (Administrative Location)	Left Bank
Central Ugenya	130
West Alego	585
South West Alego	1030
Usonga	2530
Bunyala Central	1040
Khajula	400
Total	5715

Source: Feasibility Study to Identify investment options in Nzoia

2.3 STUDY OBJECTIVES

The objective of this study was to undertake an Environmental and Social Impact Assessment (ESIA) for the project in line with Kenya's Environmental Impact Assessment and Audit regulation as well as the Environmental Management and Coordination Act (EMCA) and also with the Bank's OP 4.01. The objectives of this study were to:-

- Analyze the socio-economic and socio-environmental status of the affected areas during pre and post construction and thus justify development of the irrigation project through cost/benefit analysis and recovery of capital investment.
- Assess the National Irrigation Board's capacity to implement the proposed mitigation measures, and make appropriate recommendations, including potential capacity building and training needs and their costs.
- Based on the survey, prepare a draft Environmental and Social Management Plan ESMP that outlines:-
 1. Potential environmental and social impacts resulting from the proposed water management improvements
 2. Proposed mitigation measures;
 3. Reviewing institutional arrangements, training requirements and responsibilities for monitoring implementation of the mitigation measures with proposed monitoring indicators;
 4. Proposed work program, budget estimates, schedules, staffing and other necessary support services to implement the mitigation measures;
 5. Preparation of emergency response measures to accidents as appropriate e.g., flood damages, etc.
 6. Assess the projects impacts on existing infrastructure and social amenities

3 STUDY SCOPE AND METHODOLOGY

This chapter describes the spatial and temporal scope of the study as well as the approach and methods that were applied in undertaking this study, developing the project ESMPs and involving the public.

3.1 STUDY SCOPE

Scoping survey was undertaken during the first week of the study. The survey involved familiarization of the study area, existing environmental set up, including settlements, land uses, boundaries of the project area, and human activities among others. During the visit, the study team met with the local administration including the District Commissioners, departmental heads including the District Health Officers, Lands Officers, Agricultural officers, Water and Irrigation officers among others in Bunyala and Siaya Districts.

Specific scope and coverage of the project study will included the following:

- Analysis of socio-economic and socio-cultural baseline parameters of the proposed project area and area of influence.
- Develop an Environmental and Social Management Plan that outlines, possible impacts, mitigation measures necessary to address negative impacts and a monitoring framework.
- Assess level of compensation for impacts that cannot be avoided.
- Prepare an emergency response procedure as appropriate

The scoping exercise also resulted in the formulation of an initial Environmental Impact Identification Matrix (IIM) which was further refined as the study progressed. The matrix is presented in **table 3** below.

3.2 STUDY METHODOLOGY

3.2.1 Baseline Assessment

A baseline assessment of biophysical and socio-economic of the study area and related parameters was undertaken by the study team. The assessment was undertaken in the following ways as discussed below.

3.2.1.1 Literature Review

Desktop analysis of secondary data was undertaken to review past research done on the project area. Documents that were reviewed included among other documents:

- Feasibility studies for Nzoia project
- WKIEMP documents
- Western Kenya Community Driven Development and Flood Mitigation Project (WKCDDP) documents
- District Development Plans for Siaya, Bunyala and Ugenya
- Government of Kenya Census Reports (2010)
- Environmental and Social Management Framework for WSCR
- Integrated Pest Management Framework for WSCR
- World Bank Draft Project Appraisal Document for WSCR
- Resettlement Policy Framework-Water Security and Climate Resilience Project
- Environmental and Social Management Framework- WSCR
- Environmental Management and Coordination Act, 1999
- Environmental Impact Assessment and Audit regulations for Kenya
- Various legislative documents in Kenya relevant to this project
- World Bank safeguard policies and procedures

3.2.1.2 Ecological Survey

Transect drives and field walk through the project area was undertaken to collect data on fauna and flora types as well as the ecological characteristics of the project area. Ecosystem characteristics covering land cover, vegetation clusters, endemic and endangered species were identified. Geographical Information System (GIS) technology was used to plot and analyse spatial distribution of vegetation within the project area.

The field work consisted of checking photo interpretation boundaries and description of actual vegetation of representative areas. The actual vegetation was extrapolated for areas under cultivation. Generally an area of about one hectare was selected as the sampling point. All the tree, shrub, herb and grass species present were recorded on a vegetation description form. The percentage cover of each species was estimated, and also the physiognomic class and other site characteristics as vigour of vegetation, land use and drainage were also recorded.

3.2.1.3 Socioeconomic Survey

For socioeconomic survey, 15 enumerators were recruited within the project area. The criterion for recruiting the enumerators was that they had to be Form Four (4) graduates, being a resident of the project area and residing in one of the villages within the project

area. Therefore all the villages had at least one (1) enumerator. The enumerators were then trained for half a day and dispatched to the respective villages to test the questionnaire in order to evaluate the responsiveness of the tool and the understanding of the enumerators when administering the questionnaire. During the second day, the tools were adjusted according to the understanding the team got from the trial test.

The study area was stratified into fifteen (15) research areas based on the project area administrative sub-locations namely Magombe east, Magombe central, Magombe west, Nyadorera A and B, Sumba, Kabura Uhui, Kowala, Kalaka, Uradi Kalkadi, Umala, Khajuka, Mabinju, Rugunga and Lugare. All the villages from the sub-locations were selected and sampled based on the population. A total of 150 questionnaires were administered during the survey.

3.2.2 Project Alternatives

The study team analyzed the various project alternatives available to achieve the project's objectives but with the least adverse environmental impacts. The alternatives were identified and evaluated determining impacts and cost implications of each alternative. Alternatives assessed during this process included;

- a) Project technology including other irrigation methods (drip and overhead irrigation).
- b) Project scale and design.
- c) Site alternatives in project location particularly with regards to location based impacts and land use conflicts.
- d) Project construction, phasing, operations and maintenance.
- e) No Project alternative was also assessed to determine the impact of this No Project Scenario.

3.2.3 Public Consultation

Public consultation was conducted through public barazas. The barazas were organized by the local chiefs and sub-chiefs in the respective locations and sub-locations.

The aim of these barazas was to explain to the local community and other stakeholders about the project objectives, the proposed activities including, construction and operations and expected outputs. A total of seven (7) Barazas were held in Mau Mau, Mubwayo, Nyadorera A and B, Kabura, Rabar and Nzoia market.

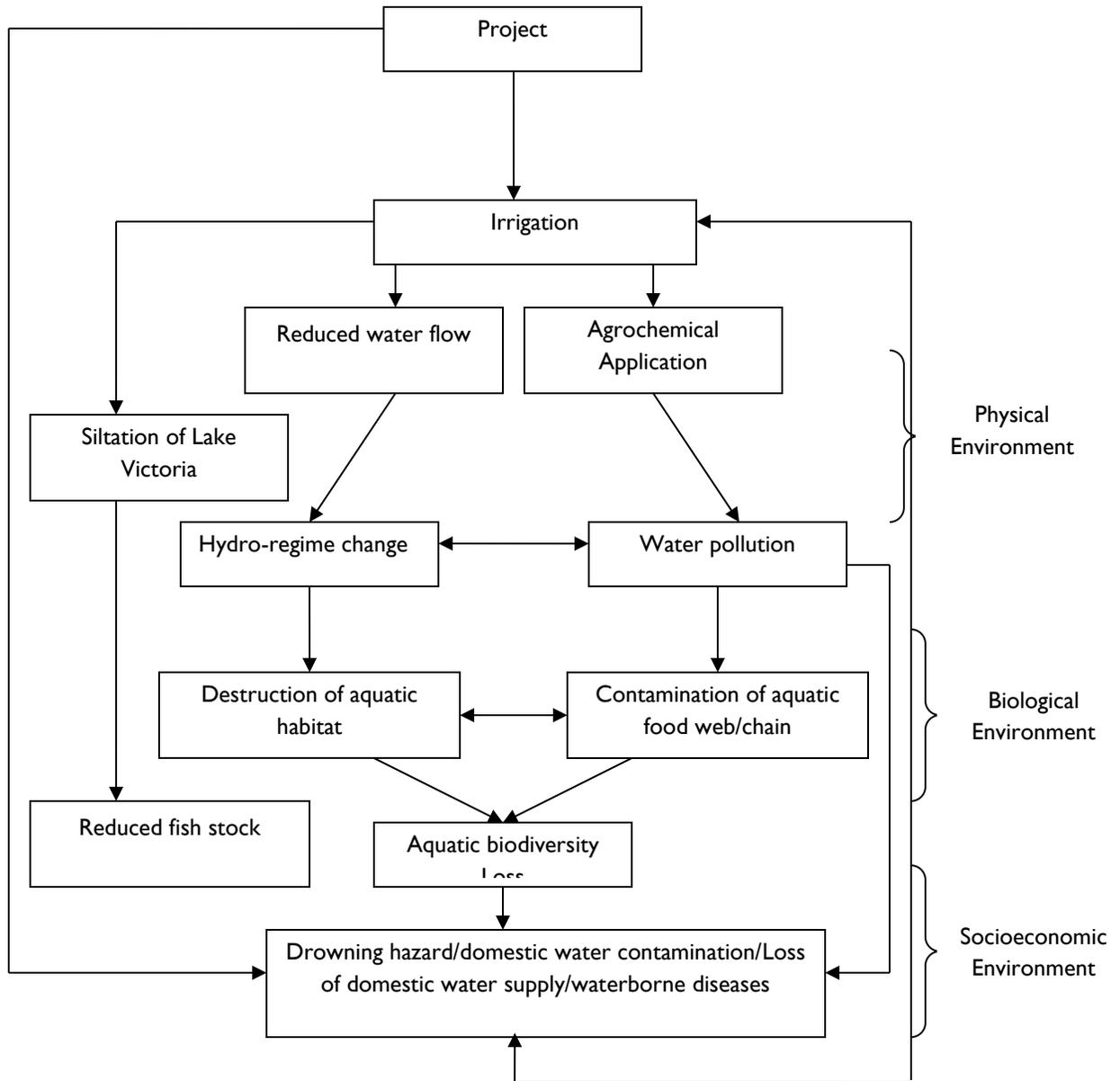
This exercise was critical in assisting the team to understand the local conditions and use of Indigenous Knowledge Systems (IKS) existing and inherent within the local communities and institutions in the project area. The stakeholders' consultation also helped in highlighting the serious socio-economic and environmental concerns and impacts that could arise from the project and was instrumental in helping to come up with feasible mitigation measures. The views of the barazas attendees were captured and noted on the Stakeholder Issues and Response format.

3.2.4 Impact Prediction and Evaluation

Various methods and techniques were applied in impact identification, prediction and evaluation. The consultants with the help of stakeholders identified and analysed potential impacts linking these with specific project activities and phase. First the task was to consider both positive and negative impacts of the project. While considering the impacts, the study examined them in light of their characteristics i.e. nature (positive or negative), extent (spatial), occurrence (one-off, intermitted or constant), magnitude, whether reversible or irreversible, direct or indirect, probability of occurrence and significance with and without mitigation. The exercise also examined the cumulative effects of impacts and particularly on land use and water quality.

A number of tools were applied to identify and assess impacts. A simple structure checklist was used to identify environmental impacts while a matrix was used identifying activities-impacts relationship. An impacts network was used to identify indirect and cumulative networks. The paths and activities-impacts relationship is illustrated figure 2 below.

Figure 2: Nzoia Environmental Impacts Network



3.2.5 Environmental and Social Management Plan

This plan identified the measures (that is the environmental protection and limitation measures) to be undertaken at all the stages of the project including the design, construction, operation and decommissioning.

Based on the identified potential adverse impacts an Environmental and Social Management Plan that encompasses a monitoring schedule was developed. The

management plan highlights all anticipated impacts and their areas of occurrence. It also provides the mitigation measures to be undertaken and the duration within which such measures are to be instituted. The plan also identify the personnel responsible for implementing particular action plans as well as give an indication of the approximate costs of these activities.

4 PROJECT DESCRIPTION

This chapter describes the technical aspect of the project as well as project layout and activities to be undertaken during the preparation and operation of the project. The chapter also describes the inputs and outputs of the project during the project life cycle.

The Lower Nzoia Phase 1 Irrigation Scheme (left bank, 4000 ha), as the first step of irrigation development in the lower basin, would develop about half of the total calculated water withdrawal of both banks (7,000 hectares). The design study indicated that the total amount of irrigation water abstraction is around 6.4 m³/s at peak in January when 80% dependency flow is around 20.8 m³/s, which is sufficient to satisfy irrigation needs without any detrimental effects on downstream in-stream flow requirements. Water Resources Management Authority (WRMA) is reviewing the withdrawal permit application and will issue the license accordingly. The National Irrigation Board (NIB) is finalizing the review and modifications of the detailed design according to a schedule that will allow implementation by mid 2013. The detailed design study will cover around 3,500 ha on the right bank (Phase 2) in addition to the left bank (Phase 1).

The project has a net irrigable area of between of about 4,000 ha in the Lower Nzoia area. The proposed technology is gravity canal irrigation with furrow or basin irrigation at farmers' plot levels. The sub-project comprises activities under the following items:

- A. Irrigation and Drainage Infrastructure. The key features of these infrastructure are as follows:
- Diversion weir and intake facilities to command about 4,000 ha on the left bank (Phase 1) and about 3,500 ha on the right bank (Phase 2)
 - Headwork, spillway, and sedimentation basins
 - Network of canals and drains down to farmers' fields and flow control structures,
 - Flood control facilities including dyke construction, enhancement and other associated structures (most of which are being carried out as part of the ongoing World Bank-financed Western Kenya Community Driven Development and Flood Mitigation Project)
 - Farm road network and passages and technical buildings
 - Other ancillary facilities

The technical design of the scheme is such that, in the event that droughts intensify, it would be possible to shift from surface to drip irrigation for plots devoted to high value crops. Given that there is no water use downstream of the scheme before the river reaches Lake Victoria and that there is scope for developing irrigation in the upper part of the basin by developing storage, shifting to drip would be needed only in the long run, if at all.

- B. Agriculture and Value Chain Enhancement. This would include assistance in setting up - and financial support to - sustainable and inclusive value chain

arrangements intended to help farmers grow and market high value crops in the long run. Activities would include supporting extension services to farmers, improving timely access to agricultural inputs, and assisting farmers to contract with buyers. It would also include provision of some critical marketing infrastructure such as storage facilities. It would also include provision of critical marketing infrastructure, such as storage facilities.

- C. Participatory Irrigation Management. This would include defining and implementing appropriate systems and processes for management, operation and maintenance of irrigation-related functions with involvement of Irrigation Water Users Associations (IWUAs) in order to contribute to investment sustainability. Capacity-building activities for farmers and NIB staff on water management would be provided.
- D. Sub-project Execution. This would include sub-project management cost during project construction, implementation of ESMP, establishment and deployment of an adapted monitoring and evaluation system that includes performance indicators, and supervision of construction.

4.1 PROJECTS ACTIVITIES

The Lower Nzoia Irrigation Development Project will involve the construction of new water abstraction, conveyance, and distribution and drainage structures. It will also involve the construction of inspection and farm roads along the major infrastructure and farmers' fields.

4.1.1 Irrigation Method

Supply of irrigation water to the farm blocks will be through surface irrigation methods. These will range from large basin and furrow units based on the irrigation sub area. Micro basin irrigation method will be adopted for the sub areas with high slopes and as a measure of reducing land grading. Basin irrigation will be applied for rice cultivation, while furrow and micro-irrigation will be used for upland crop. The related structures to be used in the secondary and main canals will have the function of conveyance (inverted siphons, culverts and bridges), regulation (turnout and checks), protection (spillway, drop and cross drains); the others will include e.g. cattle toughs/canal and side filtering structures.

4.1.2 Drainage System

The functions of drainage canals are to drain water out to outlets or disposal points and to control the ground water table. The layout of the irrigation system and topography are the main factor for determining the location of the drainage canal. The natural streams at this stage are as much as possible used in locating the main drainage canals. Since the project area is situated above the highest water level of the Lake, all the drainage system will be gravity types and all will drain back to river Nzoia. The drains are also classified as (i) main drain (ii) secondary drains (iii) tertiary and field drains. The drain sizes will be designed according to the expected discharges and other factors e.g. the soil condition. At the lower level towards Lake Victoria, Ndekwe stream will

need to be extended to reach the lake to efficiently remove drainage and excess overland water.

4.1.3 Improvement of the Existing Roads

Within the project area at least there is one single road that will traverse the length of the irrigation area. Though it will not be straight through the length, it will need improvement. There are other existing murram road networks that are within the irrigation area, which will need improvement by murram to at least 200 mm. In addition, there will be excess roads required along the main and secondary canals.

4.2 PROJECT DESIGN

The project works under this component include the following (this description is based on the April 2012 Final Design by the consultant Otieno Odongo and Partners (OO&P) expect for the weir site location as preferred by NIB to be A-2, and the conveyor canal from site A-2 to site B):

- 1 No. head works (diversion weir and intake);
- Conveyor Canal
- 1 No. sedimentation Basin;
- 1 No. main division box;
- 1 No. aqueduct across the river to the left bank;
- 1 No. Main canal;
- 11 No. secondary canals;
- Several tertiary canals / water courses;
- 3 No. main drainage canals and several secondary and field drains;
- Related irrigation and drainage structures;
- On-farm development works;
- Farm roads along the main, secondary and tertiary canals;
- Flood protection dyke (to be financed under WKCDD&FMP);
- Other works.

4.2.1 Head Works

A gravity concrete weir intake will divert and supply irrigation water for both Phases 1 and 2 of the Lower Nzoia Irrigation Development Project. The pumping option was considered but was then disqualified primarily due to the high operation and maintenance costs and water supply interruptions in the event of breakdowns, as indicated in a recent study on Options Assessment of Intake Facilities for the Nzoia Irrigation Scheme. Results from a recent study on Options Assessment of Intake Facilities does actually indicate that operation and maintenance costs for a pump intake are significantly higher than for a gravity intake and for this reason not recommended as an option (*see Draft Report by Lead Expert, September 2012*).

With a 6.7 m height and 105 m length, the selected gravity intake site has the least backwater effect - and therefore impact - on the upstream areas and will ensure full command of the previously identified project area. The Detailed Design Consultancy

under procurement (to be completed by June 2013) will further review and prepare the detailed design, with possible alignment/location adjustments if necessary.

In the recent study referred to above, several gravity intakes were assessed, including two previously identified intakes at sites A and B, both located upstream of the Old Nzoia Bridge (Site B about 0.83km upstream of the bridge and Site A 3.32km).

After evaluation and comparison of the gravity intake sites, Site A-2 has been selected as it has the least backwater effect on the upstream areas and will ensure full command of previously identified project area and an additional area upstream of Site B (additional area to be determined and indicated in Final Design Report). The Detailed Design Consultancy under procurement (to be completed by June 2013) will further review and prepare detailed design for the weir. The tentative weir design data and characteristics for Site A-2 are given in **Table 4 below**.

Table 4 Weir design data and characteristics (Site A-2)

Weir	Data and characteristics
Type of foundation	Rock
Design flood (m ³ /s)	979 (100 years return period)
Weir crest length (m)	105
Weir height (m)	6.7
Weir top width (m)	1.8
Weir base width (m)	6.77
Weir material	Mass concrete

The weir has reinforced concrete retaining walls on either side, as well as earthen barrier dyke (embankment) to prevent flow around it and, thereby, to eliminate erosion that may lead to undermining and damage/collapse of the weir. Further protection will be provided on the river bed in form of selected stones in mass concrete for the downstream apron and tipped rocked in the upstream apron. The head works would also incorporate the intake and sluicing facilities with control gates.

4.2.2 Sedimentation Basin

Due to the high silt load in the river, a sedimentation basin is incorporated in the design. The basin should be located immediately downstream of the head works and as much as possible should employ self-flushing function. The exact location will be determined during the detailed design stage.

4.2.3 Main Canal

The main canal is almost 40 km long. The design discharge of the main canal is 6.4 m³/s for the initial section up to a division box for Phases 1 and 2 and, thereafter, 3.2 m³/s for Phase 1. Irrigation experts hired by the NIB are reviewing the intake volume and main canal design, which is expected to produce more optimized/downsized design. Most parts of the main canal would be earthen sections, with only a few lined sections.

4.2.4 Secondary Canals

There are 11 secondary canals at a proposed total length of 47.7 km. The command area of the secondary canals is 3,900 ha, the balance of 153 ha being served by tertiary canals/water courses directly from the main canal.

4.2.5 Tertiary Canals/Water Courses

The tertiary canals/water course would abstract water from the main or secondary canals to farms. The exact design length will be provided based on further design review.

4.2.6 Feeder Canals

Feeder canals are to get water from the tertiary canals / water courses into the individual farms. However, at this stage it is not clear the number and the length in the Final Report of the Design Consultant. The cost would be included under farm development costs.

4.2.7 Drainage System

The drainage system will include three main drains, several secondary drains and on-farm drainage and field drains. Also, when the flood protection and control works are implemented under the Kenya Community Driven Development Project, there will be a need to construct interface drainage works (interceptor drain and drainage pumping stations along the outer side of the flood protection dykes). These works will be necessary to drain the catchment area under LNIDP as well as the drainage water from irrigation in the project areas. It is expected that these works will be included under the WKCCDDP.

4.2.8 Access Roads

Access roads are indicated as being provided along the 11 secondary canals but it is not clear whether these are also provided along the tertiary canals. Details will be provided later during the detailed design stage, but cost has been included in the present estimated cost.

4.2.9 Flood Control and Protection Works

The needed flood control and protection works including dykes construction, enhancement and other associated structures will be included in the on-going IDA Western Kenya Community Driven Development and Flood Mitigation Project. However, portion of their cost will be used in the financial and economic analysis of this project.

4.2.10 Other Structures

Several structures are proposed:

- Main division box (to split the flow for Phases 1 and 2);
- Aqueduct (to convey flow from left to right bank of the Nzoia River for Phase 2);
- Culver crossings;

- Turnouts;
- Drop structures.

Details on numbers for culverts, drops and turnouts are missing from the design report and will be provided based on further design review and modifications.

A. Agriculture and Value Chain Enhancement

Given the large amount of perishable crops that would be produced on the scheme, it is critical that adapted activities for agricultural development and value chain enhancement are designed and implemented – for those activities that can before actual crop production begins – under the sub-project. Similarly, agricultural support is essential for farmers to realize potential yields. Support would be provided in the following areas:

- Setting up - and financial support to - sustainable and inclusive value chain arrangements intended to help farmers grow and market high value crops in the long run;
- Extension services to farmers and introducing improved agricultural techniques such as SRI for rice;
- Improving access to agricultural inputs;
- Liaising with private sector entities involved in agribusiness and providing assistance to farmers to contract with such entities;
- Providing marketing infrastructure such as storage facilities;
- Capacity building for farmers and NIB staff; and
- Land leveling, as required.

B. Participatory Irrigation Management

In line with GoK policies related to agriculture and irrigated agriculture, the Lower Nzoia Irrigation Scheme execution and management structure will involve beneficiaries throughout detailed design, construction and eventually operation and management. This activity would define the roles and responsibilities, as well as establish the appropriate systems and processes for all irrigated-related functions, with involvement of Irrigation Water Users Associations (IWUAs) in order to contribute to investment sustainability and performance. This would include support for: water management from intake to farmers' fields; infrastructure operations and maintenance; scheme financial and administrative management; relationships with service providers; establishment of a monitoring and evaluation system that sets out key performance indicators; and mechanisms to ensure dialogue between NIB and farmers. Technically, the scheme would be managed by both NIB and farmers through IWUAs. NIB would be responsible for managing the head works, main canal, and other complex hydraulic structures, while IWUAs would manage the lower level canals and structures. This activity would include: provision of technical assistance; provision of office equipment; installation of GIS for IWUAs; training, including in water efficient techniques both for immediate and long-term climate resilience; and provision of critical equipment for operations and maintenance.

4.2.11 Detailed Design Works

Before the start of any construction works, the detailed design will have to be undertaken and this is estimated to take a maximum one-year. This period will at the same time be used for preparation of the tender documents. The necessary land acquisition and mobilization for this project will also be agreed upon with the farming community in this period before commencing the civil works. This is anticipated to assist in the smooth running of the project.

4.2.12 Construction Works

The construction of civil works for this project will take four years from commencement. It is suggested that for the first year of construction, 500 ha of land should be brought under irrigation. In the subsequent years, the hectares covered should be increased up to 1000. The schedule of the project implementation is often affected by the progress of the development of the tertiary and on farm units. Therefore the on farm development should include participation of the farmers, who have the land. Most of the farmers are not so familiar with irrigation farming and probably need a considerable time for water management practices. It is, therefore, deemed practical to develop the tertiary units on reasonable pace with the farmers.

4.2.13 The Implementation Period for the Project

The implementation period of Phase 1 is expected to be four years. It would be carried out in stages to allow benefits to start early in the implementation period. The works would start with the head works (weir, settling basin, canal intake and sluice gates) and the irrigation and drainage system in the project Zone 1 which would be constructed over 18 months to allow flows to be diverted to the irrigation system in Zone 1. The Second Stage would be completed after 30 months, the Third Stage after 40 months and the Fourth and final Stage after 48 months. The bidding documents should allow clear stipulation regarding implementation in stages and the contractor should prepare his construction program accordingly.

4.3 CONSTRUCTION EQUIPMENT

It is expected that machinery will be used in the construction of the main and secondary canals together with the main drains. This will be due to expected earth volume to be moved. Choice will therefore be made for the proper equipment required for the execution of the relevant work. Among the works is the excavation, loading, hauling, spreading and compacting.

Excavation or use of the machinery will be considered where there is adequate space. Small works and others where space is a hindrance, labour will be the best alternative. The basic principle for the works will be as follows:

- Excavated materials will be used within proximity
- Use of soil and the foundation should be based on sound soil and geological information.
- Borrow pits will be used only where there is need.

Concrete works will be by following the basic principles. A mixture of manpower and appropriate machinery will be used, as is convenient also particularly to maximize use of labour. It is also fortunate that construction materials such as sand and gravel are available within the Nzoia River. A separate ESMP will be required to be developed by the contractor for the quarry sites or borrow pits that will be needed to obtain construction materials.

4.4 IRRIGATION AND DRAINAGE WATER REQUIREMENTS

The Design Consultant OO&P in his Final Design Report of April 2012 (Section 8.4, Page 88) stated the following:

“The maximum gross irrigation requirement of the mixed cropping pattern at the distributary outlet is 0.45 l/s/ha the requirement per 4041 Ha NCA for Month of January is 1.83 m³/s. The figure has been adopted and has been increased by 15% to allow for a margin of safety, producing the final continuous design watering rate at the distributary outlet of 0.52 l/s/ha.

Because of social pressures and practical difficulties caused by night-time irrigation, only day-time watering is recommended. It is essential; however, that full use of the daylight is made so that scheduling can be organized correctly. Therefore a 12 hour irrigation day has been adopted. The actual design watering rate at a distributary outlet during the irrigation day is therefore 1.04 l/s/ha”.

However, a team of hired agronomist and agricultural economist have updated the cropping pattern and accordingly water requirements for the selected crops and the revised cropping pattern were worked out by the irrigation team as shown in the following **Table 5** below which also shows the water balance and environmental flows and water availability after meeting the requirements of Phase I &II as well as the environmental flows. The highest irrigation water requirements is in July and it amounts to 4.025m³/s and 2.310m³/s for phase I and II respectively, while the environmental flows (0.3 f Q95) amounts to 8.21m³/s which leaves 43.72 m³/s as surplus in the river in that month as shown in the tables below.

Table 5: Water Requirement Calculations for Phase I & II

Phase I Water Requirements												
Crop: Paddy (Rice)	Cropped Area						1943					
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
ETo (mm/day)	4.80	5.00	4.70	4.20	3.80	3.60	3.70	4.00	4.50	4.70	4.50	4.60
Kc per month					1.10	1.10	1.15	0.95				
Crop water need (ETo*Kc) mm/day	0.00	0.00	0.00	0.00	4.18	3.96	4.26	3.80	0.00	0.00	0.00	0.00
Crop water need (ETo*Kc) mm/month	0.00	0.00	0.00	0.00	125.40	118.80	127.65	114.00	0.00	0.00	0.00	0.00
SAT (Land preparation water) mm				150.00								
PERC Water (mm/month)					90.00	90.00	90.00	90.00				
WL establishment requirement (mm)					100.00							
Rainfall (mm/month)	44.00	70.00	120.00	196.00	135.00	56.00	37.00	66.00	71.00	103.00	95.00	62.00
Effective Rainfall (Pe) (mm/month)	16.40	32.00	71.00	131.80	83.00	23.60	12.20	29.60	32.60	57.40	51.00	27.20
Irrigation Water Need IN (mm/month)	0.00	0.00	0.00	18.20	232.40	185.20	205.45	174.40	0.00	0.00	0.00	0.00
Irrigation Water Need IN (mm/day)	0.00	0.00	0.00	0.61	7.75	6.17	6.85	5.81	0.00	0.00	0.00	0.00
Overall Scheme Efficiency	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500
Gross Irrigation Water Need IN (mm/day)	0.00	0.00	0.00	1.21	15.49	12.35	13.70	11.63	0.00	0.00	0.00	0.00
Flow (l/s/ha)	0.00	0.00	0.00	0.14	1.79	1.43	1.59	1.35	0.00	0.00	0.00	0.00
Area (ha)				1943.00	1943.00	1943.00	1943.00	1943.00				
Flow (l/s)	0.00	0.00	0.00	272.86	3484.21	2776.57	3080.16	2614.65	0.00	0.00	0.00	0.00
Flow (m3/s)	0.00	0.00	0.00	0.27	3.48	2.78	3.08	2.61	0.00	0.00	0.00	0.00
Crop: Food Crops (maize, s/potatoes)												
Season 1	428						Season 2					
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
ETo (mm/day)	4.80	5.00	4.70	4.20	3.80	3.60	3.70	4.00	4.50	4.70	4.50	4.60
Kc per month			0.40	0.80	1.15	0.70			0.40	0.80	1.15	0.70
Crop water need (ETo*Kc) mm/day			1.88	3.36	4.37	2.52			1.80	3.76	5.18	3.22
Crop water need (ETo*Kc) mm/month			56.40	100.80	131.10	75.60			54.00	112.80	155.25	96.60

National Irrigation Board

Rainfall (mm/month)	44.00	70.00	120.00	196.00	135.00	56.00	37.00	66.00	71.00	103.00	95.00	62.00				
Effective Rainfall (Pe) (mm/month)	16.40	32.00	71.00	131.80	83.00	23.60	12.20	29.60	32.60	57.40	51.00	27.20				
Irrigation Water Need IN (mm/month)			0.00	0.00	48.10	52.00			21.40	55.40	104.25	69.40				
Irrigation Water Need IN (mm/day)			0.00	0.00	1.60	1.73			0.71	1.85	3.48	2.31				
Overall Scheme Efficiency	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500				
Gross Irrigation Water Need IN (mm/day)			0.00	0.00	3.21	3.47			1.43	3.69	6.95	4.63				
Flow (l/s/ha)			0.00	0.00	0.37	0.40			0.17	0.43	0.80	0.54				
Area (ha)			428.00	428.00	428.00	428.00			606.80	606.80	606.80	606.80				
FLOW (l/s)			0.00	0.00	158.85	171.73			100.20	259.39	488.11	324.94				
FLOW (m ³ /s)			0.00	0.00	0.16	0.17			0.10	0.26	0.49	0.32				
Crop: Vegetables (tomatoes, onions, kales, etc.)	Season 1		218			Season 2	607									
Crop - Vegetables	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec				
ETo (mm/day)	4.80	5.00	4.70	4.20	3.80	3.60	3.70	4.00	4.50	4.70	4.50	4.60				
Kc per month	0.45	0.75	1.15	0.80			0.45	0.75	1.15	0.80						
Crop water need (ETo*Kc) mm/day	2.16	3.75	5.41	3.36	0.00	0.00	1.67	3.00	5.18	3.76	0.00	0.00				
Crop water need (ETo*Kc) mm/month	64.80	112.50	162.15	100.80	0.00	0.00	49.95	90.00	155.25	112.80	0.00	0.00				
Rainfall (mm/month)	44.00	70.00	120.00	196.00	135.00	56.00	37.00	66.00	71.00	103.00	95.00	62.00				
Effective Rainfall (Pe) (mm/month)	16.40	32.00	71.00	131.80	83.00	23.60	12.20	29.60	32.60	57.40	51.00	27.20				
Irrigation Water Need IN (mm/month)	48.40	80.50	91.15	0.00	0.00	0.00	37.75	60.40	122.65	55.40	0.00	0.00				
Irrigation Water Need IN (mm/day)	1.61	2.68	3.04	0.00	0.00	0.00	1.26	2.01	4.09	1.85	0.00	0.00				
Overall Scheme Efficiency	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500				
Gross Irrigation Water Need IN (mm/day)	3.23	5.37	6.08	0.00	0.00	0.00	2.52	4.03	8.18	3.69	0.00	0.00				
Flow (l/s/ha)	0.37	0.62	0.70	0.00	0.00	0.00	0.29	0.47	0.95	0.43	0.00	0.00				
Area (ha)	218.00	218.00	218.00	218.00			607.00	607.00	607.00	607.00						
Flow (l/s)	81.41	135.41	153.32	0.00	0.00	0.00	176.81	282.89	574.45	259.47	0.00	0.00				
Flow (m ³ /s)	0.08	0.14	0.15	0.00	0.00	0.00	0.18	0.28	0.57	0.26	0.00	0.00				
Crop: Pulses & Sunflower	Season 1		242			Season 2	607									

National Irrigation Board

Crop - Pulses (Soya beans, G/grams, G/nuts, Sesame, sunflower)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec				
ETo (mm/day)	4.80	5.00	4.70	4.20	3.80	3.60	3.70	4.00	4.50	4.70	4.50	4.60				
Kc per month			0.35	0.75	1.10	0.60			0.35	0.75	1.10	0.60				
Crop water need (ETo*Kc) mm/day	0.00	0.00	1.65	3.15	4.18	2.16	0.00	0.00	1.58	3.53	4.95	2.76				
Crop water need (ETo*Kc) mm/month	0.00	0.00	49.35	94.50	125.40	64.80	0.00	0.00	47.25	105.75	148.50	82.80				
Rainfall (mm/month)	44.00	70.00	120.00	196.00	135.00	56.00	37.00	66.00	71.00	103.00	95.00	62.00				
Effective Rainfall (Pe) (mm/month)	16.40	32.00	71.00	131.80	83.00	23.60	12.20	29.60	32.60	57.40	51.00	27.20				
Irrigation Water Need IN (mm/month)	0.00	0.00	0.00	0.00	42.40	41.20	0.00	0.00	14.65	48.35	97.50	55.60				
Irrigation Water Need IN (mm/day)	0.00	0.00	0.00	0.00	1.41	1.37	0.00	0.00	0.49	1.61	3.25	1.85				
Overall Scheme Efficiency	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500				
Gross Irrigation Water Need IN (mm/day)	0.00	0.00	0.00	0.00	2.83	2.75	0.00	0.00	0.98	3.22	6.50	3.71				
Flow (l/s/ha)	0.00	0.00	0.00	0.00	0.33	0.32	0.00	0.00	0.11	0.37	0.75	0.43				
Area (ha)			242.00	242.00	242.00	242.00			606.90	606.90	606.90	606.90				
FLOW (l/s)	0.00	0.00	0.00	0.00	79.17	76.93	0.00	0.00	68.60	226.42	456.58	260.37				
FLOW (m³/s)	0.00	0.00	0.00	0.00	0.08	0.08	0.00	0.00	0.07	0.23	0.46	0.26				
Crop: Fruit trees (bananas, mangoes, citrus, etc.)/Napier grass		Season 1		1,213			Season 2	1,213								
Crop - Fruit trees/napier grass	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec				
ETo (mm/day)	4.80	5.00	4.70	4.20	3.80	3.60	3.70	4.00	4.50	4.70	4.50	4.60				
Kc per month	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85				
Crop water need (ETo*Kc) mm/day	4.08	4.25	4.00	3.57	3.23	3.06	3.15	3.40	3.83	4.00	3.83	3.91				
Crop water need (ETo*Kc) mm/month	122.40	127.50	119.85	107.10	96.90	91.80	94.35	102.00	114.75	119.85	114.75	117.30				
Rainfall (mm/month)	44.00	70.00	120.00	196.00	135.00	56.00	37.00	66.00	71.00	103.00	95.00	62.00				
Effective Rainfall (Pe) (mm/month)	16.40	32.00	71.00	131.80	83.00	23.60	12.20	29.60	32.60	57.40	51.00	27.20				
Irrigation Water Need IN (mm/month)	106.00	95.50	48.85	0.00	13.90	68.20	82.15	72.40	82.15	62.45	63.75	90.10				
Irrigation Water Need IN (mm/day)	3.53	3.18	1.63	0.00	0.46	2.27	2.74	2.41	2.74	2.08	2.13	3.00				
Overall Scheme Efficiency	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500				
Gross Irrigation Water Need IN (mm/day)	7.07	6.37	3.26	0.00	0.93	4.55	5.48	4.83	5.48	4.16	4.25	6.01				
Flow (l/s/ha)	0.82	0.74	0.38	0.00	0.11	0.53	0.63	0.56	0.63	0.48	0.49	0.70				

National Irrigation Board

Area (ha)	1212.50	1212.50	1212.50	1212.50	1212.50	1212.50	1212.50	1212.50	1212.50	1212.50	1212.50	1212.50				
Flow (l/s)	991.71	893.47	457.03	0.00	130.04	638.06	768.57	677.35	768.57	584.26	596.43	842.95				
Flow (m3/s)	0.99	0.89	0.46	0.00	0.13	0.64	0.77	0.68	0.77	0.58	0.60	0.84				
Summary																
Scheme Water Requirements, m3/s	1.073	1.029	0.610	0.273	3.852	3.663	4.026	3.575	1.512	1.330	1.541	1.428				
Irrigated area/month, ha	1430.50	1430.50	2100.50	4043.50	3825.50	3825.50	3762.50	3762.50	3033.20	3033.20	2426.20	2426.20				
Average monthly scheme water requirement, l/s/ha	0.75	0.72	0.29	0.07	1.01	0.96	1.07	0.95	0.50	0.44	0.64	0.59				

National Irrigation Board

Crop water need (ETo*Kc) mm/day	0.00	0.00	1.65	3.15	4.18	2.16	0.00	0.00	1.58	3.53	4.95	2.76						
Crop water need (ETo*Kc) mm/month	0.00	0.00	49.35	94.50	125.40	64.80	0.00	0.00	47.25	105.75	148.50	82.80						
Rainfall (mm/month)	44.00	70.00	120.00	196.00	135.00	56.00	37.00	66.00	71.00	103.00	95.00	62.00						
Effective Rainfall (Pe) (mm/month)	16.40	32.00	71.00	131.80	83.00	23.60	12.20	29.60	32.60	57.40	51.00	27.20						
Irrigation Water Need IN (mm/month)	0.00	0.00	0.00	0.00	42.40	41.20	0.00	0.00	14.65	48.35	97.50	55.60						
Irrigation Water Need IN (mm/day)	0.00	0.00	0.00	0.00	1.41	1.37	0.00	0.00	0.49	1.61	3.25	1.85						
Overall Scheme Efficiency	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500						
Gross Irrigation Water Need IN (mm/day)	0.00	0.00	0.00	0.00	2.83	2.75	0.00	0.00	0.98	3.22	6.50	3.71						
Flow (l/s/ha)	0.00	0.00	0.00	0.00	0.33	0.32	0.00	0.00	0.11	0.37	0.75	0.43						
Area (ha)			304.00	304.00	304.00	304.00			210.00	210.00	210.00	210.00						
FLOW (l/s)	0.00	0.00	0.00	0.00	99.46	96.64	0.00	0.00	23.74	78.34	157.99	90.09						
FLOW (m ³ /s)	0.00	0.00	0.00	0.00	0.10	0.10	0.00	0.00	0.02	0.08	0.16	0.09						
Summary																		
Scheme Water Requirements, m3/s	0.821	1.010	0.883	0.149	2.382	2.237	2.310	2.171	1.433	1.284	1.493	1.145						
Irrigated area/month, ha	1520.00	1520.00	2736.00	3799.00	2849.00	2849.00	2538.00	2538.00	3035.00	3035.00	2130.00	2130.00						
Average monthly scheme water requirement, l/s/ha	0.54	0.66	0.32	0.04	0.84	0.79	0.91	0.86	0.47	0.42	0.70	0.54						

National Irrigation Board

Month	Water Requirements / Probable Flows (m3/s)						
	Scheme Water requirement		Scheme Water Requirements (Ph1 & Ph2)	Q80 Probable Flow	Q95 Probable Flow	0.3xQ95 (Environmental Flow)	Balance (B = Q80-0.3xQ95-SWR Ph1/2)
	Phase I	Phase II					
January	1.07	0.82	1.89	20.82	15.86	4.76	14.17
February	1.03	1.01	2.04	14.57	6.87	2.06	10.47
March	0.61	0.88	1.49	10.98	1.31	0.39	9.09
April	0.27	0.15	0.42	14.21	8.28	2.48	11.30
May	3.85	2.38	6.23	36.00	11.18	3.35	26.41
June	3.66	2.24	5.90	58.05	24.39	7.32	44.83
July	4.03	2.31	6.34	58.27	27.38	8.21	43.72
August	3.57	2.17	5.75	70.29	42.89	12.87	51.68
September	1.51	1.43	2.95	60.02	38.91	11.67	45.40
October	1.33	1.28	2.61	42.34	31.60	9.48	30.25
November	1.54	1.49	3.03	41.81	23.48	7.04	31.73
December	1.43	1.15	2.57	27.90	17.76	5.33	20.00

4.5 CROPPING PATTERN AND HOUSEHOLDS

The irrigation area is split into four zones and 12 blocks covering 5,775 ha (the gross command area). Details on the cropping pattern by zone and the number of households by block are provided in the following **table 6** below.

Table 6 - Cropping Pattern by Zone

Crop	Zone 1		Zone 2		Zone 3		Zone 4		Total Area	
	Ha	% of Total	Ha	% of Total						
Paddy	0	0%	0	0%	0	0%	706	66%	706	17%
Maize/beans	308	30%	388	30%	197	30%	0	0%	892	22%
Tomatoes / Vegetables	308	30%	388	30%	197	30%	0	0%	892	22%
Bananas	103	10%	129	10%	66	10%	0	0%	297	7%
Passion / Fruit trees	256	25%	123	10%	66	10%	292	27%	737	18%
Sunflower	0	0%	100	8%	60	9%	40	4%	200	5%
Groundnuts	0	0%	100	8%	71	11%	30	3%	201	5%
Napier Pasture	51	5%	65	5%	0	0%	0	0%	116	3%
Total	1026	100%	1292	100%	656	100%	1068	100%	4042	100%

Source; Marketing, Financial and Economic Report NIB 2012

4.6 PROJECT IMPLEMENTATION AND MANAGEMENT

The proposed development of effective and efficient irrigation and drainage of Lower Nzoia Irrigation project will be implemented by National Irrigation Board (NIB) as the Executing Agency (EA) during the project construction as well as operation. This project will be implemented and managed under a separate Project Management Unit (PMU) that will be established by NIB. A project Management Unit will be established by NBI specifically for this project and will be headed by a project coordinator (NIB Staff) who will manage, control and operate the project office in/around the Lower Nzoia area.

4.7 PROJECT BENEFICIARIES

The investment in Lower Nzoia is expected to directly benefit over 20,000 people (2,100 households), including smallholder farmers who are currently engaged in rain-fed subsistence agriculture (primarily maize and beans) and extensive livestock rearing. Another estimated 50,000 people are expected to benefit through linkages to the scheme activities and outputs. In addition, the economy of local districts would be enhanced by irrigated agriculture.

Table 7. Irrigation Area and Beneficiaries by Block

Block	Gross area (ha)	Net area (ha)	Number of households
1	85	59	31
2	80	56	29
3	152	106	55
4	184	129	67
5	610	427	222
6	355	249	129
7	872	610	317
8	1525	1068	555

National Irrigation Board

9	938	657	341
10	289	202	105
11	188	132	68
12	497	348	181
Total	5775	4043	2100

Source; LNIDP Marketing, Financial and Economic Analysis Report –NIB 2012

About 20,000 people are expected to directly benefit from irrigation development through the increase in agricultural production and its value on a per hectare basis due to: (i) increased land productivity, including a shift from one to two cropping seasons for paddy and tomato; (ii) a shift to higher value crops with larger gross margins; (iii) a higher quality of outputs that is reflected in farm prices.

Additionally, the agricultural production and its value will increase in absolute terms as a result of the extension of area under cultivation, from the current 2,464 (half of which is grazing land) to 4,042 hectares. The sub-project will, thus, contribute to increased food security, improved nutrition, higher incomes, and generally enhanced standards of living. Thousands of other people who will be employed in various activities associated with the value chain for perishable crops – and who will likely live in the two local counties where the sub-project is located – will be indirect beneficiaries. Indirect benefits will also result from improved access to rural roads.

Figure 3 below shows the different blocks of Lower Nzoia

4.8 COST ESTIMATE

The current estimated investment costs for the proposed irrigation and drainage scheme and other activities (B-D) is approximately Ksh 3.7 billion (equivalent to US\$ 44.62 million). The breakdown by activity is as follows:

- | | |
|--|-------------------|
| A. Irrigation and Drainage Infrastructure - | Ksh 2.79 billion |
| B. Agriculture and Value Chain Enhancement - | Ksh 470 million |
| C. Participatory Irrigation Management - | Ksh 275 million |
| D. Sub-project Management - | Ksh 168.5 million |

Table 8 below provides the most recent detailed cost breakdown for Irrigation and Drainage Infrastructure.

Table 8: Cost Estimate for Irrigation and Drainage Infrastructure

Item No.	Description	Cost (million Kshs)
1	Preliminaries and General Items	109
2	Weir and Intake Works	237
3	Sedimentation Basin	18
4	Main Canal	918
6	SC1	38
7	SC2	59
8	SC3	30
9	SC4	34
10	SC5	150
11	SC6	70
12	SC7	40
13	SC8	19
14	SC9	46
15	SC10	16
16	SC11	35
17	Drain 1	61
18	Drain 2	105
19	Drain3	48
20	Secondary Drains (11)	100
	Sub-total (Irrigation)	2132
	Access and O&M Roads	41
	Day works	16
	Sub-total additional works	56
	Total	2188
	Add 15% - physical contingencies	328
	Add 12.5% - financial contingencies	274
	Grand Total	2790

National Irrigation Board

The above estimated costs for irrigation and drainage infrastructure is being reviewed and verified, relating to irrigation efficiency/rotation procedure; crop water requirements, etc. Based on the detailed design that will be completed in June 2013, the estimated cost will be adjusted accordingly.

5 PROJECT ALTERNATIVES

This section describes and examines the various alternatives available for the project. Alternatives examined during the study included alternative irrigation technology including drip irrigation, site alternatives in project location particularly with regards to location based impacts, biodiversity loss, wetland functions loss and land use conflicts was assessed. Finally a No Project alternative was also assessed to determine the impact of this No Project Scenario.

5.1 ALTERNATIVE TECHNOLOGY

The irrigation technology adopted for the Lower Nzoia Irrigation Development Project is open surface canal irrigation which consists of gravity-fed systems, where water is transported from surface sources via channels and used to flood or furrow feed agricultural land. This system is cheap in terms of capital investment in infrastructure and maintenance. However the environmental impacts of the systems are considered to be many as compared to other systems. The technology has low efficiency rates depending on environmental factors including loss of water, health impacts among others. See **table 9** for comparative analysis of alternative project technology.

Table 9: Comparative Analysis of alternative project technologies

Technology	Advantages	Disadvantages
Open surface canal irrigation	Low capital investments and maintenance	Low water efficiency (high rates of water loss)
	Gravity-fed system	
	Technology is easy to be adopt by communities	Associated with health impacts (malaria and bilharzias breeding)
Drip Irrigation	High efficient	High capital cost
		Highly mechanised

Based on the comparative analysis on **table 9** above, open surface canal irrigation adopted by project is considered to be the best in terms of all year round water availability. However the socioeconomic and ecological characteristics are not very favourable. The choice of technology is not only linked to costs and environmental aspect of the project but there are two other factors to consider when assessing the project. Due to the fluctuating water flows during the dry season, the use of water for irrigation without reservoir will not make a difference in terms of increasing productivity.

5.2 WATER SUPPLY OPTION FOR IRRIGATION

The study considered the option of supplying water for irrigation through pumping using a generator Vis a Vis the use of gravity. The pumping option was disqualified primarily due to the high operation and maintenance costs and water supply interruptions in the event of breakdowns, as indicated in a recent study on Options Assessment of Intake Facilities for the Nzoia Irrigation Scheme.

5.3 ALTERNATIVE PROJECT SITE

Gravity fed or dependent irrigation projects many a times are site specific due to land topography, water availability and farm land should be concurrent with the gravitation flow of water in order to achieve water flow into the command area for irrigation. Based

on the technology adopted for this project, finding an alternative site for the project will be difficult due to continuous availability of water and feasibility of gravity fed irrigation technology.

5.4 ALTERNATIVE SCALE AND DESIGN

Irrigation with a water reservoir infrastructure is an alternative to this project; in this case water from the natural stream is channelled to the rice fields from a reservoir. This design however, has some draw backs in terms of inundation of land by the water reservoir, health impacts of the reservoir among other impacts.

5.5 NO PROJECT ALTERNATIVE

A No project option will mean that the anticipated positive and adverse impacts do not occur and the status quo remains. However in terms of costs and benefits analysis this option would lead to economic loss of

Implementation of the proposed Lower Nzoia Irrigation Scheme Phase 1 is expected to bring approximately 4,043 ha of land under irrigation and benefit more than 2,100 small scale farmers through improved production of food and provision of incomes. It is expected that an average household will gain approximately Kshs. 392,000 from irrigated farming annually. The increase of the irrigated area from the existing 705 hectares to 4043 hectares will be a major boost to the Kenyan economy whose target is to increase the area under irrigation by 40,000 hectares annually. In addition to irrigation infrastructure, the project will benefit from support in post harvest handling and marketing infrastructure and support for management investments which are covered under components 2, 3 and 4 respectively. The project's incremental benefits are expected to be more than Kshs 1.27 billion once production stabilizes. The project is however, expected to cost more than Kshs. 4.4 Billion. Financially, the project is found to be viable resulting to acceptable discount rates and positive cash flows that will guarantee its sustainability. Further, expected household incomes are enough for the farmers to contribute towards operation and maintenance costs further guaranteeing sustainability of the project.

Economically, the project would result to positive externalities in the country as economic benefits are more than the economic costs of the project. Additionally, the provision of food to the country, creation of employment opportunities and generation of foreign exchange from tradable commodities will positively contribute towards the country's gross domestic product GDP and Balance of Payments (BOP). Compared to these benefits, the major negative externality relate to the potential pollution of the soil and water resources following use of agrochemicals and the alteration of natural flora and fauna as a result of farming activities. However, a sound social and environmental management plan has been developed against these negative externalities.

Based on the direct and indirect project benefits, a No project option is not a viable alternative for this project. Considering the fact the potential project impacts can be avoided or mitigate effectively, the project benefits outweigh the costs in terms of adverse impacts. Based on the above considered factors, a "no-project scenario" is not an attractive alternative.

6 PROJECT AREA DESCRIPTION

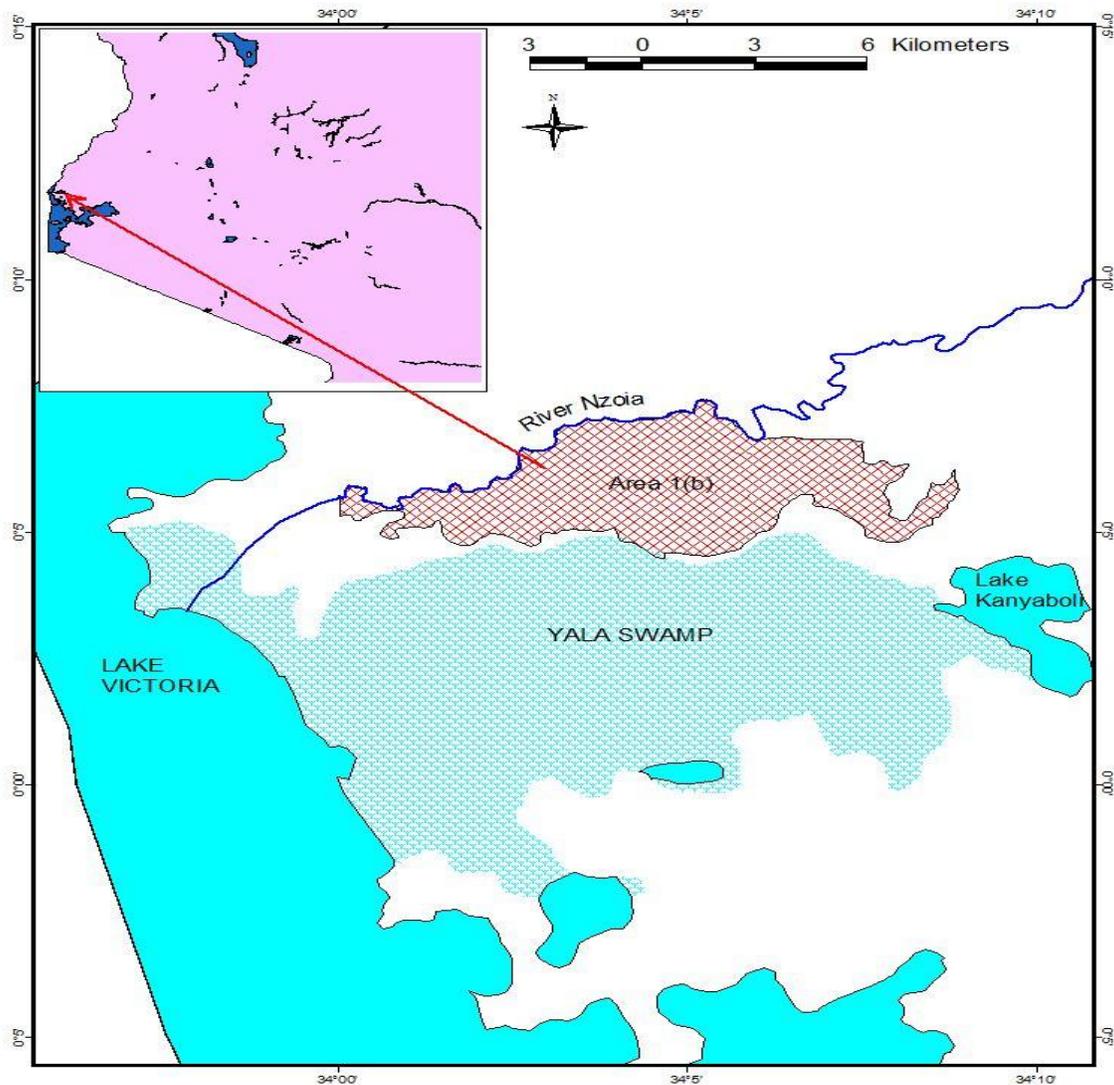
This chapter describes and assess the existing project area environment to set the benchmark upon which the impacts can be measured and eventually monitored. The chapter gives an overview description of the general Western Province and then narrows to the specific project area describing the environmental setup in detail.

6.1 PHYSICAL ENVIRONMENT

6.1.1 Location

The Lower Nzoia sub-basin is located within latitude $0^{\circ} 04'N$ and $0^{\circ} 11'S$ and longitude $33^{\circ} 57'E$ and $34^{\circ} 14'E$ covering an area of 8,500 km² with an altitude varying between 1,130m and 1,225m. The area is generally flat and prone to floods.

Figure 4: Project area location



The floodplain physiographically, falls on the sediment plain of the river within the altitude range of 1100 to 1350m above mean sea level. The floodplain topography is fairly flat to very gently undulating with gradients of less than 2%.

The Lower Nzoia Irrigation Development Project Phase 1 is located in two counties in Western Kenya, namely Siaya and Busia. Administratively the project area falls in eastern parts of Bunyala district (western province) and western parts of Siaya district (Nyanza province). Bunyala district has a total area of 306.5 Km² including water surface of Lake Victoria of 120 Km². The district has one division with 6 locations and 18 sub-locations. Siaya district has a total area of 1520 Km² and is divided into 7 divisions with 30 locations and 130 sub-locations.

In total, 16 Sub-locations within 6 Locations in 3 Districts would benefit from the project. The project would have a gross command area of around 5,800 ha excluding swamp area and about 4,000 ha in net command / cultivated area. The existing Bunyala Pump Irrigation Scheme that was developed in the late sixties and that has a net irrigable area of 400 ha is included within the project area and will be rehabilitated.

The project has a net irrigable area of between of about 4,000 ha in the Lower Nzoia area in the Lower Nzoia Basin including six locations namely Central Ugenya (130 ha.), West Alego (585 ha.), South West Alego (1030 ha.), Alego Usonga (2530 ha.), Bunyala Central (1040 ha.) and Khajula (400 ha.). The technology is gravity canal irrigation with furrow or basin irrigation at farmers' plot levels. The irrigable area covers three divisions, six sub-locations and 14 sub-locations - indicating a coverage area of 1% of the total sub-locations. The combined total areas of sub-locations whose partial areas will be covered by the project are 233.8km². The project administrative areas are presented in the **table 10** below.

Table 10: Irrigable administrative units

District	Division	Location	Sub-location	Total Area in sq.kms
Siaya	Ugunja	Central Ugenya	Umala	16.3
	Uranga	West Alego	Kalkada Uradi	10.6
			Komenya Kalaka	7.5
			Komenya Kowala	9.8
			Kabura-Uhuyi	8.3
		Usonga	Nyadorera `a	15.7
			Nyadorera `b	37.5
			Sumba	33.7
			Magombe West	21.5
	Bunyala	Budalangi	Bunyala Central	Magombe East
Magombe Central				46.9
Mabinju				7
Khajula			Lugare	4.6
			Rugunga	6.7
			Total 2	3

Source: Marketing, Financial and Economic Analysis Report-LNIDP 2012.

6.1.2 Hydrology of Lower Nzoia

Lower Nzoia area lies in Lake Victoria drainage basin, and specifically Bunyala District which was recently created from part of Busia District. Bunyala District covers an area of 306.5km² of which 120km² is part of the Lake Victoria waters. A number of significant

swampy areas exist in the area including Mundere Swamp to the north of the river and Yala Swamp to the south. Yala Swamp is fed by River Yala and is one of the largest swamps in the area as it drains into Lake Victoria via a number of small channels including Ndekwe stream which also carries drainage from Bunyala pilot irrigation scheme. The Nzoia River which emanates from the western side of Keiyo escarpment and the Cherangani Hills has meandering alignment on a flood plain that runs between levees. The river has an approximate length of 315km and drains a total catchment area of 12, 696km². The size of Lower Nzoia basin is 2593km². A significant delta has been formed downstream of the river where it discharges into Lake Victoria. This flat area is for the most of the part marshy and covered in dense reed growth.

6.1.2.1 Nzoia River

The Nzoia River and its tributaries provide a permanent water source but with varying flows throughout the seasons of the year. The River Nzoia emanates from the western side of the Keiyo Escarpment and the Cherangani Hills in well-defined channels from an elevation of approximately 2,286 metres above sea level (m.a.s.l). The river has several tributaries with an average basin elevation of 1,917m, m.a.s.l. The tributary with the highest elevation (4,300m, m.a.s.l) flows from the slopes of Mount Elgon. The River flows from a north-easterly to south-westerly direction with a mean slope of 0.010% from source to discharge into Lake Victoria at about 1,000m, m.a.s.l, (ITALCONSULT, 1981). The River Nzoia enters Lake Victoria a short distance to the north of the Yala Swamp. The plains at the downstream reaches of this River are susceptible to floods. The water quality of Nzoia River varies as per the discharge. As shown on the **table 11** below, during seasons of high discharge/rainy season upstream, there is marked increase in total suspended solids, nutrients and electrical conductivity as well as sediment load.

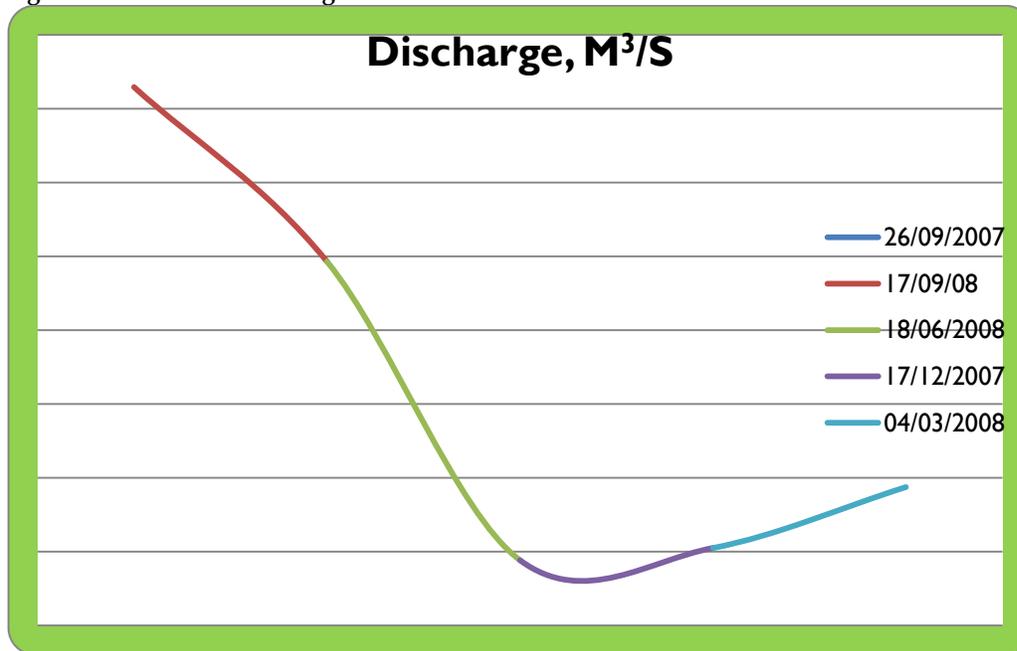
Table 11. Table Nzoia River Water quality analysis

Monitoring Station	Nzoia at Rwambwa	Nzoia at Rwambwa	Nzoia (Rwambwa)	Nzoia at Rwambwa	Nzoia at Rwambwa
Date Sampled	26/9/07	17/09/08	18/06/2008	17/12/2007	04/03/2008
Altitude (masl)	1153	1153	1153	1153	1153
Electrical conductivity (μ s/cm)	130	115	105.1	145.5	110
Ph	7.5	7.42	7.55	7.95	7.7
Temp ($^{\circ}$ C)	22.8	23.3	21.8	26.1	28.5
Dissolved Oxygen (mg/l)	3.8	6.8	7.46	4.2	5
Total Susp. Solids(mg/l)	190	210	70	70	600
Turbidity(NTU)	193		115.7	102	368
Nitrate (mgNO ₃ /l)	2.64		12.02	2.8	2.2
Discharge, M ³ /S	364.577	246.455	44.169	52.46	93.69
Sediment Load, Tonnes/day	5984.896032	4471.67952	267.134112	317.27808	4856.8896

Source. Water Resources Management Authority, 2010

Since Nzoia River is not able to accommodate all the waters especially during high flows of the river more than often the river bursts its banks in the lower region of the catchment flooding large tracks of land. The **figure 5** below shows Nzoia discharge.

Figure 5: Nzoia River discharge



Source. Water Resources Management Authority, 2010

The monthly flow of Nzoia River is as shown on the **table 12 below**.

Table 12: Monthly reliable flows (RGS 1EF01 at Ruambwa)

Month	Mean monthly Flow (m ³ /s)
January	68.4
February	45.8
March	47.4
April	100
May	172
June	139
July	148
August	186.4
September	165.8
October	135
November	126.4
December	93.1

Available flows (Q80 and Q95) at RGS 1EF01 at Ruambwa)

Month	Q80 flow (m ³ /s)	Q95 flow (m ³ /s)
January	20.82	15.86
February	14.57	6.87
March	10.98	1.31
April	14.21	8.28
May	36.00	11.18
June	58.05	24.39
July	58.27	27.38

August	70.29	42.89
September	60.02	38.91
October	43.34	31.60
November	41.81	23.48
December	27.90	17.76

Source: Final Design Report by Design Consultant (December 2011)

6.1.2.2 Ground water resource

Kenya has three rock types and hydro-geological area classified as volcanic, metamorphic basement and intrusive rocks and sedimentary rocks. Hydro geological regions can be simplified as shown in the map below. The main ground water aquifers are closely linked with the above three major rock systems. Ground water would be the last alternative to be considered in this region as there would be a need for number of boreholes. Potential groundwater depth is at an average depth of 30m. The main restriction to boreholes in the project area is the salinity of water from the boreholes and their low yields. A remedy to water shortage if it occurred would be to introduce a water harvesting culture and watershed management to ensure that water soil and land resources are properly managed.

6.1.2.3 Lake Victoria

The project area borders Lake Victoria to the east. With a surface area of 68,000Km², it is the second largest freshwater lake in the world. Lake Victoria is a habitat of over 300 endemic species of fish, 26 of which are threatened

Lake Victoria basin offers livelihood to about 11.5 million people. Nzoia is one of the major rivers that drain into Lake Victoria. Nzoia River discharges an average of 115.3 m³/s annually contributing to 14.8 % of the Lake Victoria waters. The Lake is under threat from many processes. The most important threat to the Lake is pollution. Sediment and nutrient loads from the lake catchment discharges into the lake every day. Farms are some of the sources of sediment and nutrients into the lake.

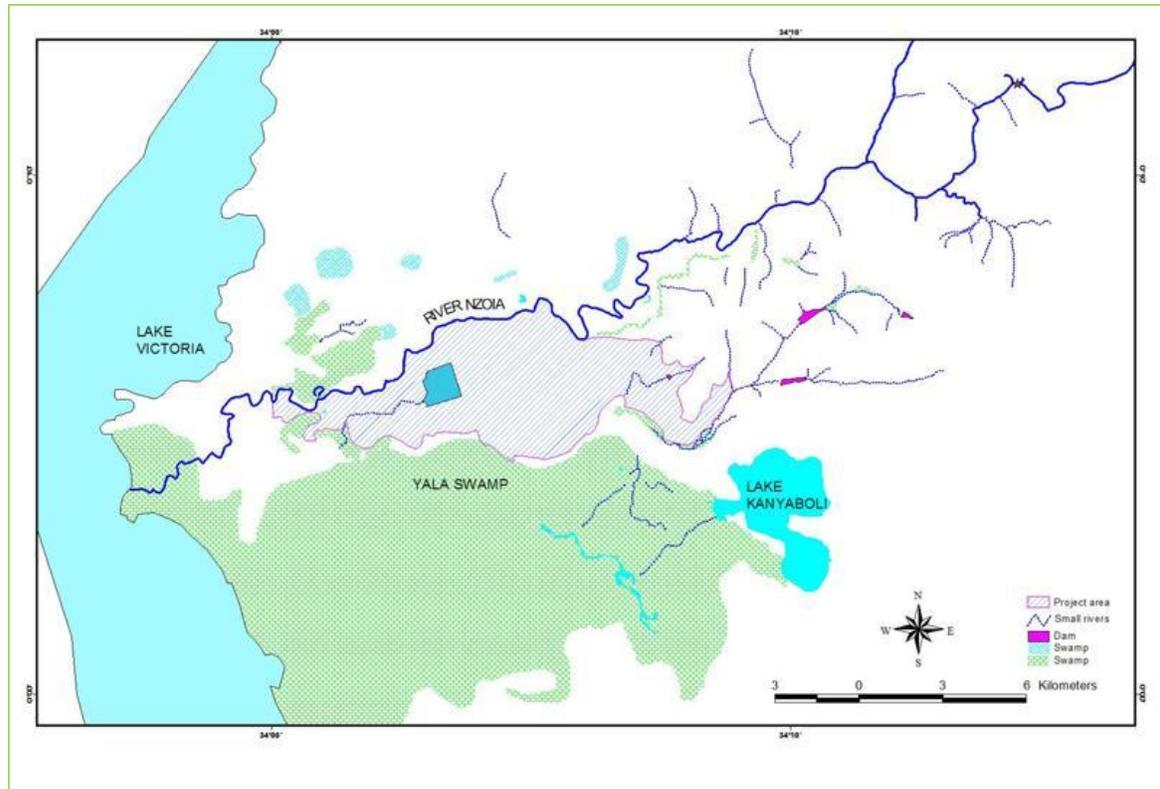


Figure 6: Hydrological map of the area.

6.1.3 Water Rights

Water rights in Kenya are held by WRMA with authority to give permits to water users. In the project location, Nzoia River is used by many with and without permit from WRMA. Many of these users are small scale thus no action has been taken by the authority. In Bunyala Irrigation Scheme, the IWUAs members are supposed to pay for the water they use from Nzoia. However this has not been the case mostly because WRMA is new and lack monitoring capacity. Though there are talks between NIB and WRMA on how to collect water fees from the farmers.

6.1.4 Climate and Meteorology

According to Nile Basin Capacity Building Network (2005) the lower plains of the Nzoia basin, where the project area lies, receives a mean annual rainfall of 1,260mm and most of which falls between March and May and a smaller peak between September and November. Extreme droughts occur in January and February. Severe convectional rains occur near the shores of Lake Victoria and the highest recorded intensity has been 23mm during a five-minute period in 1961. The mean annual maximum temperature ranges between 25^o and 30^oC while the minimum is between 9^o and 18^oC. The discharge varies from lows of 28m³/s to maximum of 930m³/s. The annual runoff amounts approximately 310mm with a runoff ratio of 21.7% (Nile Basin Capacity Building Network, 2005).

The Nzoia River Basin Management Initiative a public private partnership programme 2006-2011, (2006) describes the climate of the Nzoia river basin where project area lies as tropical humid and that the area receives four seasons annually due to the inter-tropical convergence zone (ITCZ) and that the local relief and the Lake Victoria also modify the local weather pattern.

6.1.4.1 Rainfall

Lower Nzoia monthly rainfall totals showed a bimodal distribution with the highest peak occurring during March/May (long rains), August /September (short rains). The rain gauge at Busia suggests that short rains are more intense than long rains in the Lower Nzoia region.

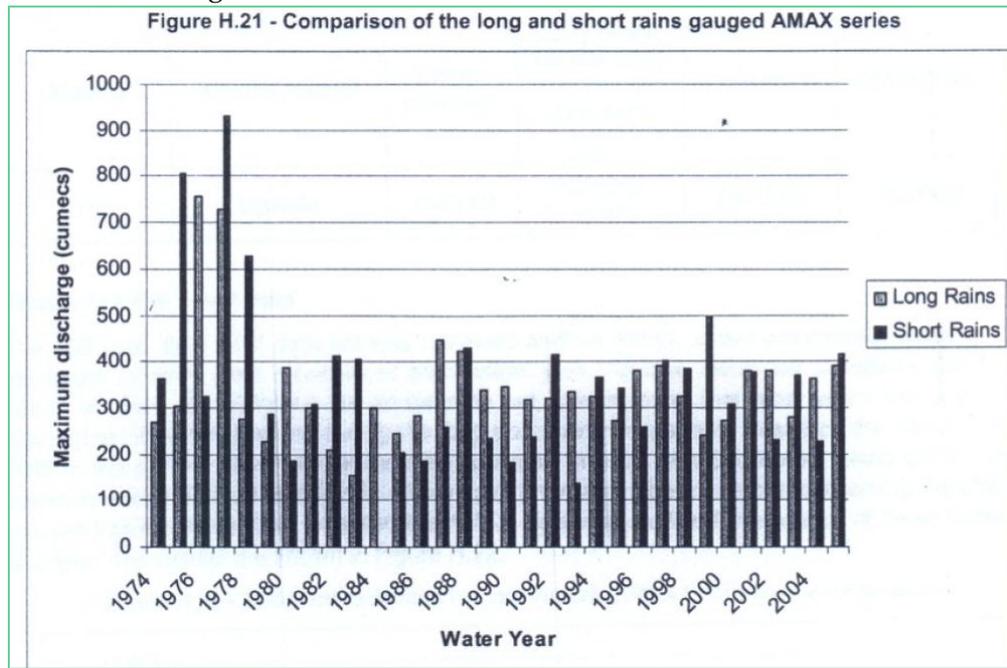


Figure 7. Rainfall Pattern; Source

6.1.4.2 Temperature

Long-term average air temperature varies between 19°C to 25°C. Daily temperatures fluctuate between 15°C and 30°C. The evaporation in this region exceeds rainfall in most months except April/May.

6.1.5 Drainage

The principal drainage trend follows the general slope to the southwest towards Lake Victoria. Along the Nzoia River there are swamps and streams that arise from both sides of the river. In the lower reach as the river approaches Lake Victoria, Busia and part of Siaya districts the basin has a flatter topography; hence the Government has been undertaking construction of drainage works, mostly to keep off floods. Along the river the slope reduces from 0.5% in the upper reaches to 0.04% in the lower reaches over the last 30km which is in the area of the project (Nile Basin Capacity building Network, Flood Management Research Cluster 2005). They also describe the discharge as varying from lows of 28m³/s to maximum of 930m³/s and that the highest river discharges occur

between May and September while the lowest discharges occur between January and March.

6.1.6 Geology and Soils

The soils of the project area are developed mainly on alluvial deposits and mudstones. According to ITALCONSULT (1980) the soils (Based on: FAO-UNESCO recommendations, Kenya Soil Survey and Reconnaissance Land Classification Survey USBR method of 1953) of the Upper Nzoia (18,000 ha) and Lower Nzoia (12,000 ha) respectively are mainly laterized and deep of alluvial origin. In the Lower Nzoia Area the soils are clay in texture.

The soils of the uplands within the surveyed area are developed on granites and mudstones. The soils developed on granites (UGm) are well drained, moderately to extremely deep, strongly weathered, red to strong brown, sandy clay, in places fairly rocky and bouldery (Ferralsols, Plinthosols and Acrisols). The soils developed on mudstones are well drained, shallow to extremely deep, rather strongly weathered, red to strong brown clay, in places petroplinthite at the surface. The soils classified as Acrisols and Plinthosols). The soils of the minor valleys (VXC) are developed on various undifferentiated parent materials. They are well drained to poorly drained, shallow to very deep soils of varying colour, consistence and texture. The soils are classified as Verti-Eutric Fluvisols and DystricGleysols, sodic phase; Eutric Planosols and Vertisols; Ferralic Cambisols, rudic phase and Eutric Plinthosols.

The soils of the project area are developed on alluvium and colluvium derived from various parent materials. They show a wide range of characteristics and include relatively little weathered and stratified alluvial and colluvial soils (**figure 8**).

River terraces and floodplains found along the Nzoia River and along the fringes of the Yala swamp possess soils which are developed on recent alluvial deposits. The soils consist of somewhat excessively drained to poorly drained, deep to very deep, dark reddish brown to dark brown, mottled, loose to very firm, stratified sand to clay. In places the soils are slightly saline and slightly sodic and they are formed of cracking clay. These soils are prone to salinization due to the salinity and poor drainage characteristics. The soils are shown on the **figure 8** below as SA1, SA2, SA3, SAC1 and SAC2 (Kenya Soil Survey 1991). The soil codes are *annexed E*.

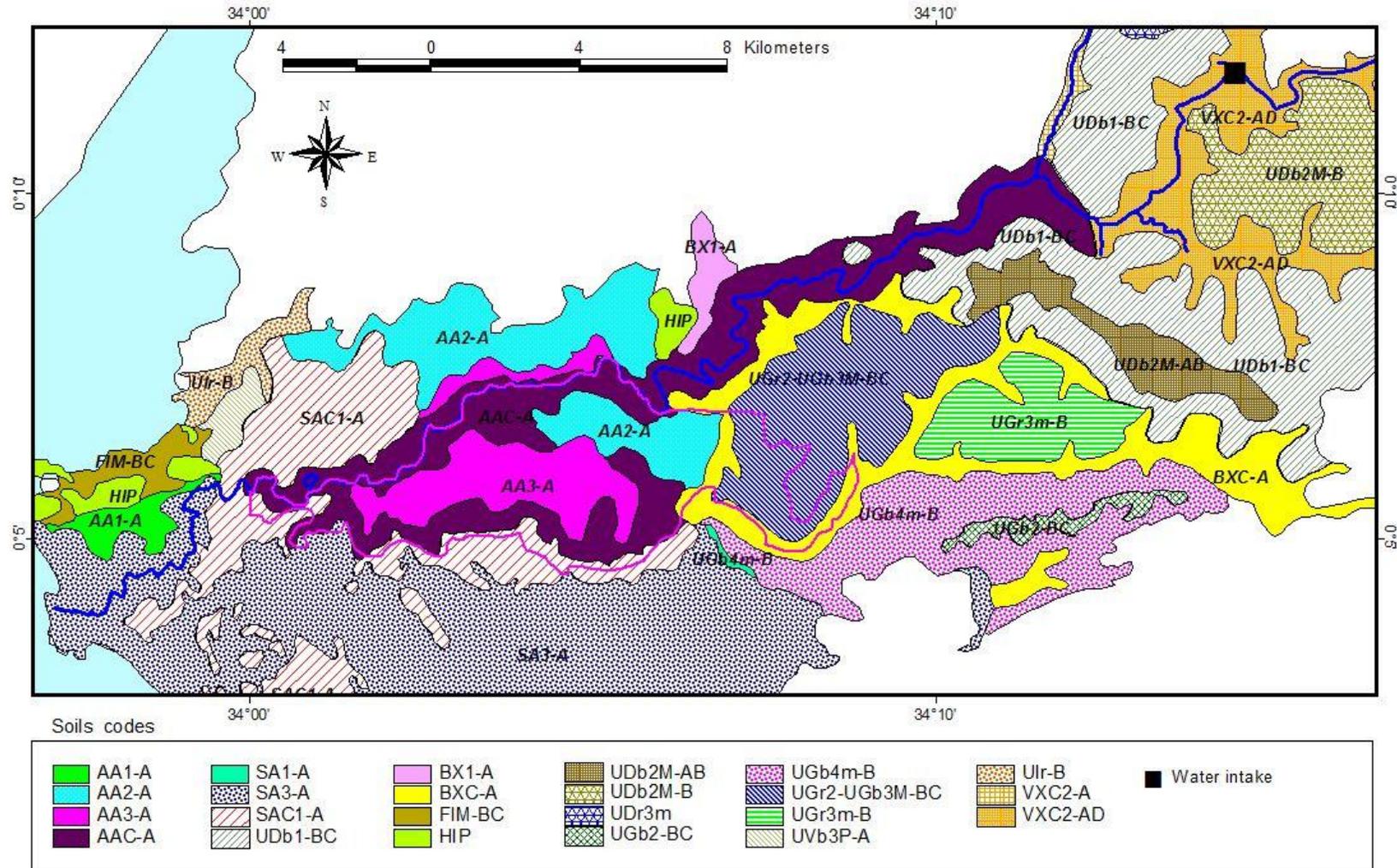
This study also placed the lands in classes 2, 3 and 6 of classification system of US Bureau of Reclamation and methodology. There was no Class 1 because as they all suffer from some limitations. Class 4 was not considered since it has no provision for this at reconnaissance level. The study observed that both the upper and Lower Nzoia could support irrigation and that the soils were generally poor in mineral and organic fertility.

The project area generally covers Agro-Climatic Zones (ACZ) I, II, III and IV (Jaetzold and Smith, 1982) from the upstream proposed two water intake sites to areas adjacent to Lake Victoria, an indication of increasing climatic aridity towards the Lake. Though ACZ IV and III could be the areas for irrigation to be considered, these areas within the

National Irrigation Board

project area are prone to flooding and water logging due to the flat to very gently undulating relief of the area.

Figure 8: Soil types in the project area



6.1.7 Land Tenure and Use

There are three categories of land ownership in the project area, i.e. government land, trust land and community and private land. According to Land Adjudication Office Siaya and Survey of Kenya Nairobi, most of the land in the project area is categorized as community or private free hold. 67% of the farmers' possessed documents to prove land ownership. Even for those who did not have documents, it was because succession may not have been done and such ownership was not in dispute.

The project has a gross command of 5780 ha. Of this area 30% is covered by settlements, infrastructure, fallow for bushes and shrubs and trees. Of the remaining 4000ha, 72% is under rain fed agriculture. The average land size for individual Project Affected Persons households is 2 acres. The average number of structures per parcel of land is 4.

The gross area of the Lower Nzoia Basin is estimated at over 25,000 ha. This area has swamps, shrub land and agricultural land (cropland, pasture and fallow) as the main uses. It is estimated that about 17,000 ha is available for agriculture. It is also estimated that the present land use is in the order of less than 30% by the farming community.

Despite being a floodplain area for Nzoia River, the area has various types of vegetation are recognized in the area. Evergreen or semi evergreen tree bushes and grasses generally cover the hilly lands. The lowland is mostly grassland with shrubs and is often seasonally swampy.

Traditionally, the economy of the people is dependent on agriculture and on animal husbandry mainly at the subsistence level. The main crops are maize and sorghum, which are extensively cultivated. Other common crops are peas, beans, groundnuts, sweet potatoes, cassava and bananas.

The original landscape can be described as an area divided by slightly higher, better drained ridges, covered by bush land ,swamps and marshes, covered by papyrus, reeds and sedges. The upper part of the study area has higher ground altitude with better rainfall and therefore able to support natural bush land vegetation. The lower area being an estuary of the Nzoia and the Yala rivers is lower and prone to flooding, forming wetland before the Lake Victoria shores. Three major landscape types are distinguished:

1. The "settlement area", slightly higher, better-drained land. The village or homestead areas have farmhouses encircled by hedges, woodlots and roads are found in these areas.
2. The "cropping area", this area is the transition zone from the higher ridges to the depressions. The area has better drainage than the depressions and therefore allows the growing of "dry feet" crops, mainly food crops. The food crops in these areas are normally intercropped as follows:
 - Maize/sorghum; Maize/sorghum/cowpeas; Maize/sorghum/beans
 - Maize/sorghum/ green grams; Maize/cotton; Maize/cassava
 - Sugar Cane/Maize

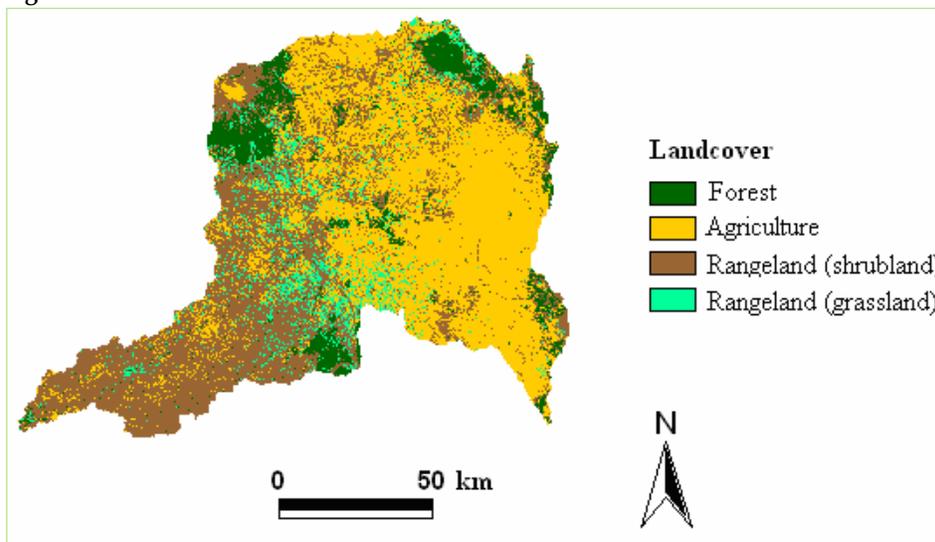
The dominant land use in the region is agriculture and the main food crops include maize. This cropping area runs into the wetter area bordering the depressions ensuring that the risk of crop failure due to drought during a dry year and towards the end of the rainy period. In an extremely wet year, the dry areas perform better.

The “swamp area”, the very wet areas are covered by permanent or seasonal swamps. This land use is found on the shores of Lake Victoria, the banks of Nzoia River and on the southern part of the project area which is Yala swamp. These bottomlands and swamps occur at altitudes ranging from 1140-1260 m with relief intensity of less than 5 m and slopes of less than 2%. The main swamp is found in the southwest of the survey area (Yala Swamp). River Nzoia also has swamps along part of their courses. The bottom lands occur in the north-eastern corner of the survey area and on the eastern side of the Yala swamp.

Less than 10% of the project area is cultivated with maize and sorghum. The interviewed survey raised reasons for the low cultivation intensity in the area which evolved around inadequate rainfall and floods. The project areas experiences severe flooding and as a result flood control measures are constantly being implemented in the area. Once these efforts are controlled, the project area may be able to increase in expand irrigated rice production and irrigated sugar cane farming. Presently, the major undertakings of the people of the area are rice farming (on tenant basis) in the Bunyala Irrigation Scheme, part-time fishing and temporary keeping of cattle, goats, poultry and sheep.

The other 90% of the area has been left fallow due to flood water. Within the project area there are no natural habitats. The lack of natural vegetation is due to floods and cultivation of the area when the flood water recedes. As shown on the **figure 9** below, the project area is shown as shrub land.

Figure 9. Land cover of Nzoia catchment



6.2 BIOLOGICAL ENVIRONMENT

6.2.1 Flora

Most of the vegetation cover is composed of shrubs like *lantana camara*, and a few indigenous trees that are threatened by pressure from the charcoal burning and brick making activities. Scrubland and Savannah are characteristic of the project area. This vegetation is scanty with poor sparse grasslands around homesteads whereas the grazing fields are a mixture of tufted grasslands with thick bushes and scrub. Reed vegetation is also found in the areas where water floods during the rains, mostly resulting from the River Nzoia overtopping its banks.

The shoreline of Nzoia River is lined with the belt of papyrus (*Cyperus papyrus*) and other wetland grasses. Toward Lake Victoria the wetland comprises a mixture of *Cyperus papyrus* in most inundated places and *Phragmites mauritianus* in the drier and higher grounds. In areas where flood water has not receded, secondary vegetation of papyrus reeds have started colonising these areas. **Figure 10** shows the distribution of ecosystems in the area.

6.2.1.1 Forestry

Bunyala district has forest area in various hills in the district. The main forest activity is community based agro-forestry and individuals' woodlot practices where the local farmers are encouraged to plant trees in their home compounds and farms especially those trees that add nitrogenous compounds to the soils and those which provide fodder. Agro-forestry plays the dual role of enriching the soil, while providing protective vegetation cover and wood fuel for domestic energy supply. Exotic trees such as the Blue gum, *agravena* sp, among others, have been planted in the farms. The district has no gazetted forests apart from a few hilltops where trees have been planted by the forest department, such as Mbagha hill, Akala hill and Odiedo hill. The forestry programmes have been concentrated on hilltops where catchment afforestation is done for environmental conservation and provision of firewood and timber for construction purposes. Several other non-gazetted hilltops in the district are being encroached upon by individuals due to very high population pressure and resultant excessive cultivation. The area is also characterised by increasing land degradation and decrease in forest areas due to human related activities mainly excessive logging, There is also a poor attitude among the community towards environmental issues and little agro-forestry is practiced in the farms. There is still need to gazette some of the hilltops and enforce environmental compliance.

Within the project boundaries there are no forests due to human settlements and floods. As indicated above, the population have planted exotic tree species. **Table 13** below provides ecosystem types around the project area.

Figure 10: Ecosystem types

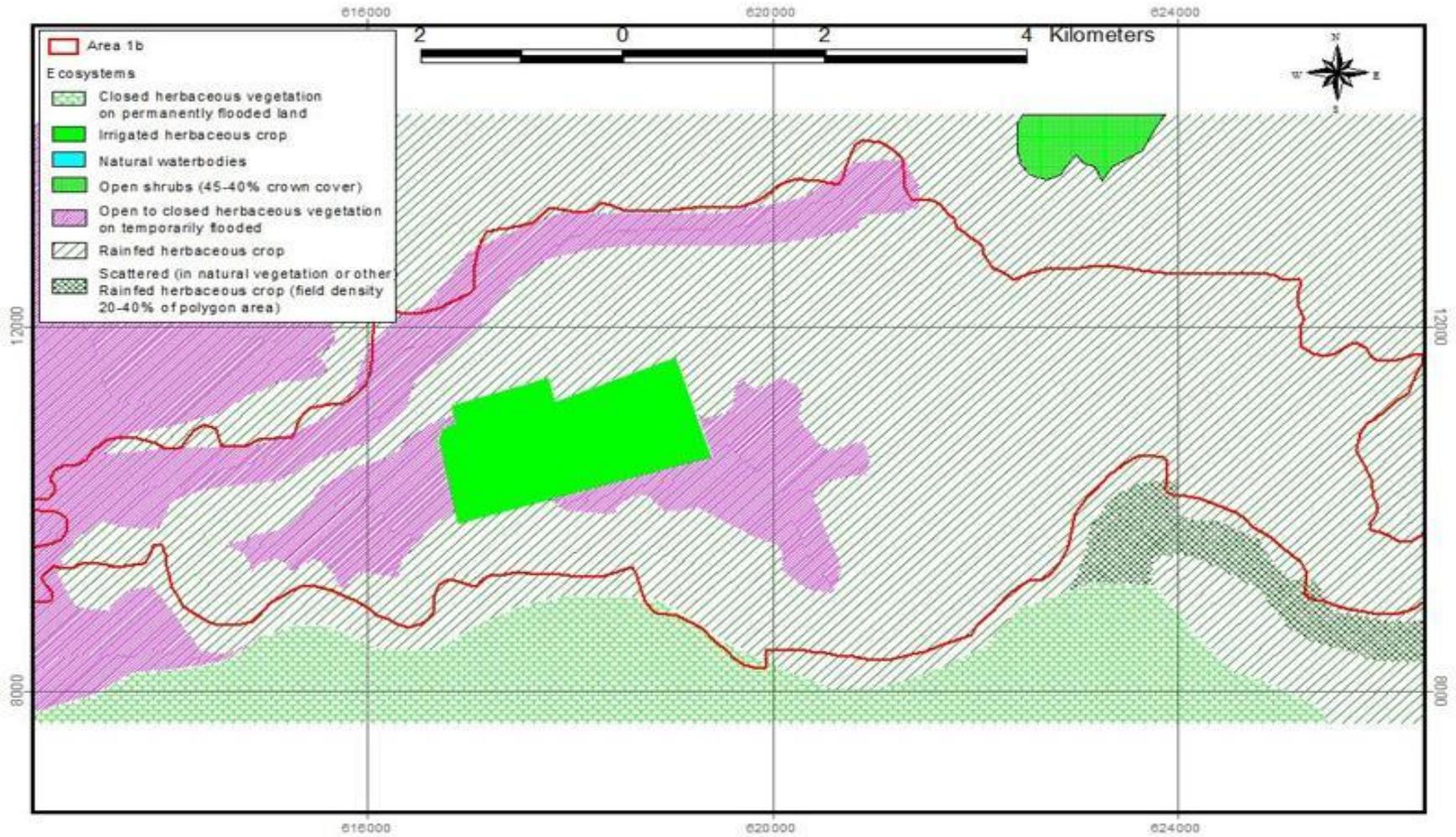


Table 13: Ecosystem types around the project site

LCID	LANDCOVER	AREA	PERIMETER	ACRES
AG-2	Irrigated herbaceous crop	2960951.554	7768.715	67.974
RL-5	Open to closed herbaceous vegetation on temporarily flooded	2592942.592	10343.800	59.526
RL-5	Open to closed herbaceous vegetation on temporarily flooded	1832290.473	7258.978	42.064
RL-6	Closed herbaceous vegetation on permanently flooded land	11211217.175	28101.297	257.374
AG-1B	Scattered (in natural vegetation or other) Rain fed herbaceous crop (field density 20-40% of polygon area)	3255500.829	15964.260	74.736
WB	Natural water bodies	100332.974	1277.206	2.303
FR-7	Open shrubs (45-40% crown cover)	749945.143	4074.687	17.216
FR-7	Open shrubs (45-40% crown cover)	13357.738	564.825	0.307
RL-5	Open to closed herbaceous vegetation on temporarily flooded	22930822.260	44021.326	526.419
AG-1	Rain fed herbaceous crop	67306394.671	108254.064	1545.142

The ecosystem types around the project area in comparison to the national ecosystem type are as shown on the **table 14** below.

Table 14: National Ecosystem type

NATIONAL COMPARISON				
LCID	LANDCOVER	AREA	PERIMETER	ACRES
RL-5		8212648436.455	16757164.130	188536.463
RL-6		1430051751.925	4603831.392	32829.472
AG-1B		20533944137.043	28593861.874	471394.493
WB		13309425425.519	9618186.601	305542.358
FR-7		33688448791.346	43245592.078	773380.386
AG-1		49022301370.466	42221420.424	1125397.183

6.2.2 Fauna

There are no animal species which require special attention in terms of conservation within the project boundary. However the neighbouring swamps of Yala on the southern and marshy areas of Lake Victoria inhabit wild animals.

The common animals in the periphery of the swamp include: water buck (*Kobus defassa*), bush buck (*Tragelaphus scriptus*), sitatunga (*Tragelaphus spekei*), reed buck (*Redunca*), warthog (*Phacochoerius*) and velvet monkey (*Cercopithecus aethiops*). Warthog is a serious menace in this area as it destroys crops planted in the cleared areas. Other wildlife animals found within the swamp are: crocodiles, hippos, hyenas, wild pigs, leopards, baboons, jackals, gazelles, impala and porcupine.

6.2.2.1 Avifauna

White-faced whistling ducks, African open-billed Stork, White-faced tress ducks, Comb duck or Knob billed ducks, Egyptian Geese, Spur-winged Geese, Doves, Pigeons, Black-chested snake eagles, Eurasian Marsh Harrier, Black-shouldered Kite, Wahlerg's eagle and the Western Banded Snake-eagle are among the bird species that are found in the project area. These are found in Yala swamp (see section 5.4.1). The swamp is recognised as an Important Bird Area (IBA) due to its rich diversity of birds by Bird Life International (Retrieved September 14, 2010 from <http://www.birdlife.org/datazone/sites/index.html?action=SitHTMDetails.asp&sid=6431&m=0>) (Table 15). Some of these bird species can be sighted in the project area especially within the Bunyala Irrigation Scheme.

Table 15: Common Birds of the Yala Swamp and its Environs

Common Name	Scientific Name
Squacco Heron	<i>Ardeola ralloides</i>
Purple Heron	<i>Ardea purpea</i>
White necked Cormorant	<i>Phalacrocorax carbo</i>
Egret	<i>Egretta sp.</i>
Hammer Kop	<i>Scopus umbretta</i>
Black kite	<i>Milvus migrans</i>
Crested Eagle	<i>Lophaetus occipatilis</i>
Fish eagle	<i>Haliaeetus vocifer</i>
Harrier Hawk	<i>Polyboroides typus</i>
Mouse bird	<i>Colius striatus</i>
Swift	<i>Apus sp.</i>
Wagtail	<i>Motacilla flava</i>
Grey Headed Gull	<i>Larus cirrocephalus</i>
Guinea fowl	<i>Numida meleagris</i>
Riparia	<i>Riparia sp.</i>
Black headed Gonolo	<i>Laniarius erythrogaster</i>
Weaver Birds	<i>Ploceus sp.</i>
Crested Crane	<i>Balearica regulorum</i>

Source: Field Assessment

6.3 SOCIO-ECONOMIC ENVIRONMENT

6.3.1 Population and Demography

The Nzoia Irrigation project traverses sixteen sub-locations. According to the 2009 Kenya population census, these sub-locations had a total population of 54,201. 46.1% of the populations are male while 53.9% are females. The ratio of male to female is 1.133:1. 53% of the Project Affected Persons (PAPs) are below 20 years while about 10% are above 60 years. There are a total of 13,273 households and the average population density is 299 persons per km². The average household size is 5.9 with Kalkada Uradi having the highest number of 7.5 members and Kochieng B having the lowest number of 4 members per household.

On average a household head has 10 dependents, made up of one wife and 6 children. The composition of the population shows that young people below 19 years make over 50% of the total population. The District Development Plans (DDPs) in Siaya and Bunyala indicate that 40% and 66% respectively are classified to be experiencing absolute poverty in rural areas.

6.3.2 Settlement Patterns

Siaya district has a total land area of 1,520 km² while Bunyala has 306.5 km². Of this total land area, the arable area in Siaya district is 80.1% but reduces to 60.7% in Bunyala district. Despite high percentages of arable land areas, land use in the districts is below optimal as the practices disregard the need to conserve the soils and renew the soil fertility. Land is publicly and privately owned in the project districts. In Siaya district, 90 per cent of the land has been adjudicated and 197,325 title deeds issued.

The area is densely populated along the lake region due to pronounced fishing activities in the district. Plains of Bunyala are characterized by scarce population because it is prone to periodical flooding. Most of the population is concentrated in the urban areas of Port Victoria due to increased number of immigrants from the neighbouring districts to carry out lucrative fishing. **Table 16** below summarizes housing building materials in the project districts:

Table 16: Housing building materials in the project districts

District	HH distribution by main wall materials					HH distribution by main Roofing materials			
	Stone	Brick/Block	Mud/Wood	Mud/Cement	Other	Corrugated Sheet	Iron	Grass	Other
Bunyala	0.7	7.2	85.4	6.0	0.7	59.0		40.8	0.2
Siaya	2.7	9.5	73.1	14.3	0.5	63.7		34.5	1.7

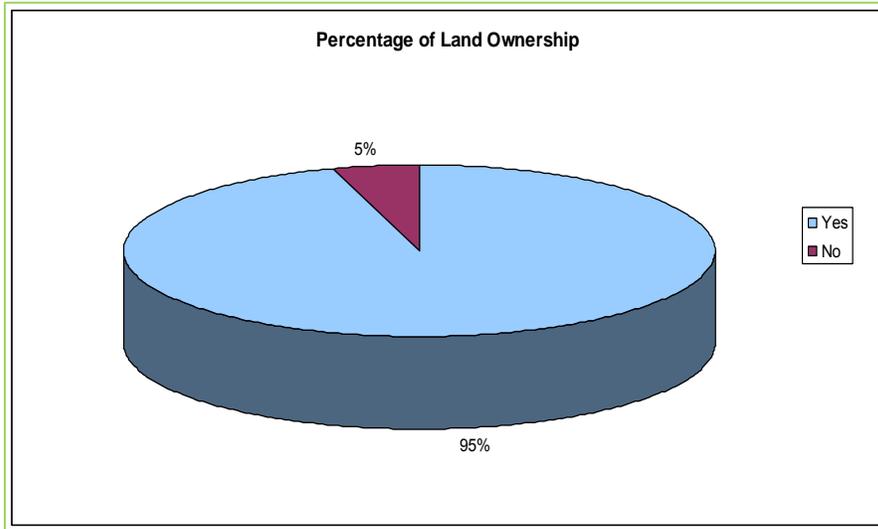
Source: Kenya Integrated Household Budget Survey, 2005/06 and District Plans

Houses are constructed with the exterior ground raised above adjacent ground level to prevent shallow floodwater from entering. The raised part is usually well compacted against the wall and the ground level. Also houses in the flood prone areas are made of thicker walls than those in higher parts of this area. During walling, properly mixed mud is placed from exterior side of the wall, so that when damaged, mud that cave from the wall piles at the outside part of the house. There are two construction techniques practiced in this area; houses constructed to resist damage by floodwater and those constructed temporarily.

6.3.3 Land Tenure System

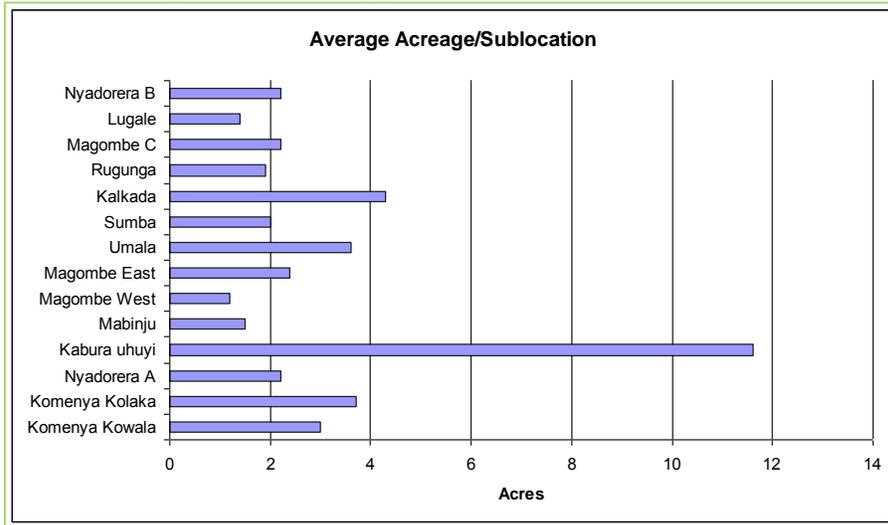
There are three categories of land ownership in the project area, i.e. government land, trust land and community and private land. According to Land Adjudication Office Siaya and Survey of Kenya Nairobi, most of the land in the project area is categorized as community or private free hold. 67% of the farmers' possessed documents to prove land ownership. Even for those who did not have documents, it was because succession may not have been done and such ownership was not in dispute. Land in the project area is either private owned land with free hold title or registered land owners with Ministry of Lands while waiting provisions of the title deeds. According to the socioeconomic survey, 95% of the respondents own the land in the area as shown on **figure 11** below.

Figure 11: Land ownership amongst the respondents



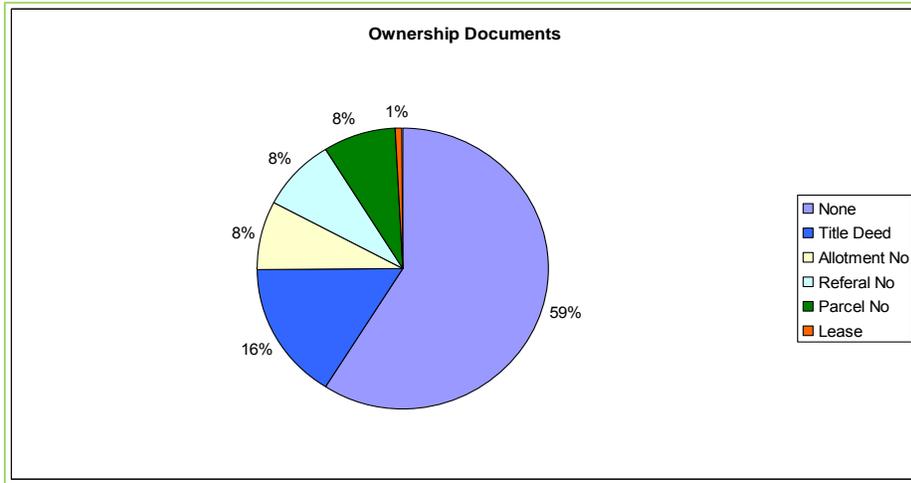
The remaining 5% lease the land for cultivation. Kabura sub location has the largest parcels of land per household in the project area as shown on **figure 12** below. The average land ownership in Kabura is 11.8%. Magombe West has the minimum land holding with an average of 1 acre per household.

Figure12: Average land ownership per household



Half of the sampled population have no legal land ownership documents. 16% have title deeds, 8% have allotment letters, and same percentage has referral letters while another 8% have parcel number. One percent leases the land (**figure 13**).

Figure 3: Percentage of population with land ownership documents



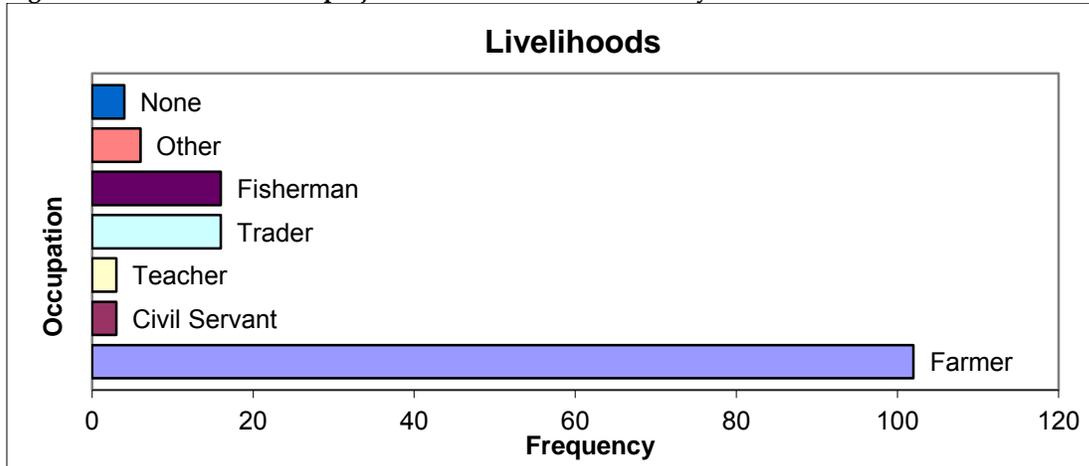
Due to frequent flooding of the land, land adjudication in the area was not completed. This is the reason for high number of the population without title deeds.

6.3.4 Livelihoods

There are various livelihoods means in the area. The household survey revealed that most of people in the project area are farmers with a frequency of 100, followed by traders and fishermen at 15, with a small fraction employed either as teachers or civil servants as illustrated in the **figure 14** below. The three most important livelihood strategies in the study area are crop farming, livestock rearing and casual labor in the rice fields or in other people's farms. Other livelihood strategies in Bunyala that were found to be important are business, craftsmanship and formal employment to a lesser extent.

Rice farming is ranked as the most important economic activity in the area, which is sustained by a wide market in their local communities as this is their staple food, as well as in the adjacent regions and in neighboring towns both near and far. Rice from Bunyala is sold to communities and centers as Kampala and Bungoma.

Figure 14. Livelihoods in the project area from household survey



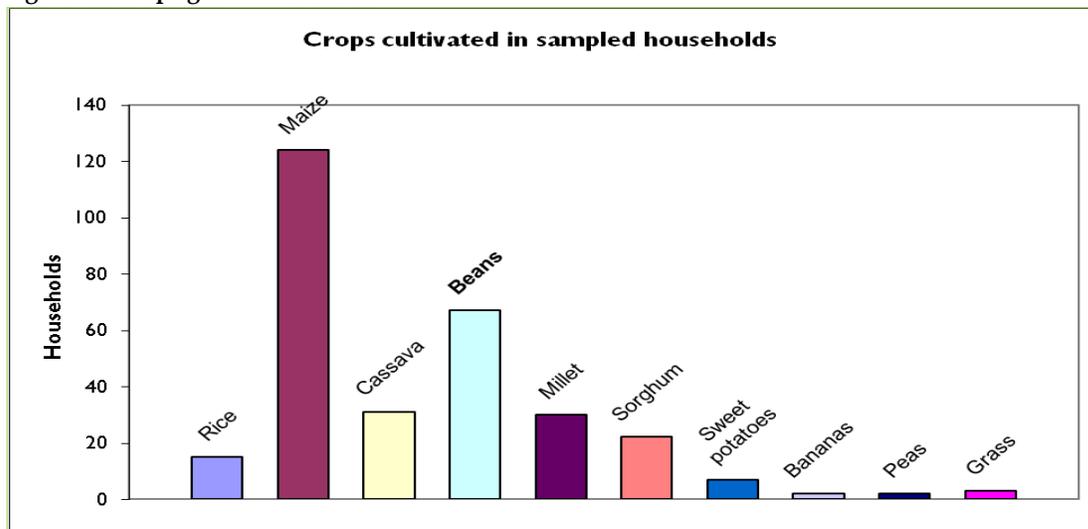
6.3.4.1 Agriculture

Both drainage and irrigation agriculture is practiced in the area where small scale farming dominates with average farm sizes varying from 1.02 Ha in Siaya to 2.5 in Bunyala. Interviews in the project area revealed that only 10% of the population used irrigation in crop growing and the rest (90%) relied on rain fed agriculture.

Bunyala district has a total approximate area of 300ha under irrigation benefiting approximately 2000 people against a potential of 40,000 people. Siaya district has approximately 1000 ha under irrigation against 3,000 ha, of potential area. Anyiko (Siaya district), is the only irrigation scheme within the proposed project area rice irrigation scheme to increase irrigable area from 50 ha to 80 ha.

The main food crops produced in the districts are maize, sorghum, finger millet, beans and cassava. Traditionally, cotton, bananas, sugarcane and tobacco have been the main cash crops. However, Irrigated rice, palm oil, chilli and grain amaranth have emerged as major alternative cash crops and are increasingly gaining prominence. According to the survey, maize is the most cultivated crop in the area followed by beans shown on the figure 15 below.

Figure 15: Crops grown in the area



Other crops grown in small scale include sugarcane, sweet potatoes; Green vegetables (kale and indigenous greens) grow with partial irrigation. Farmers use kitchen water, spring water and intricate systems of trenches for catching rainwater to irrigate, mostly by hand.

Pests and disease control is becoming increasingly an important aspect of production in the study area. Some of the pests and diseases facing production of crop in the study area

- Hailstones: They were reported in pockets of the District during the long rains season.

- Quelea Quelea birds: These are serious pests in the rice fields and also on the sorghum fields.
- Cassava Mosaic Disease
- Wilt of Tomatoes
- Maize Streak diseases
- Panama disease of Bananas
- Armyworms
- Greater Grain Borer

Agricultural sector is the highest overall contributor to household incomes in the project districts as presented on **table 17** below.

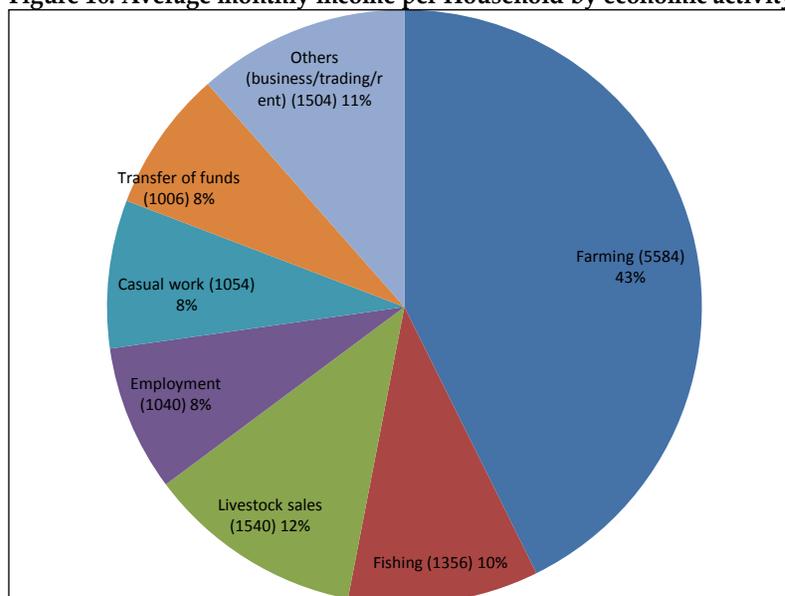
Table 17: Sectoral contribution to Household incomes

Sector	Sectoral contributions to house hold income (%)	
	Siaya	Bunyala
Agriculture	65.6	38.2
Urban self-employment	15.3	3.8
Rural Self-employment	8.8	39.1
Wage employment	9.2	10.2
Other	1.1	5.7

Source: District Development Plans (2008-2012), Siaya and Bunyala

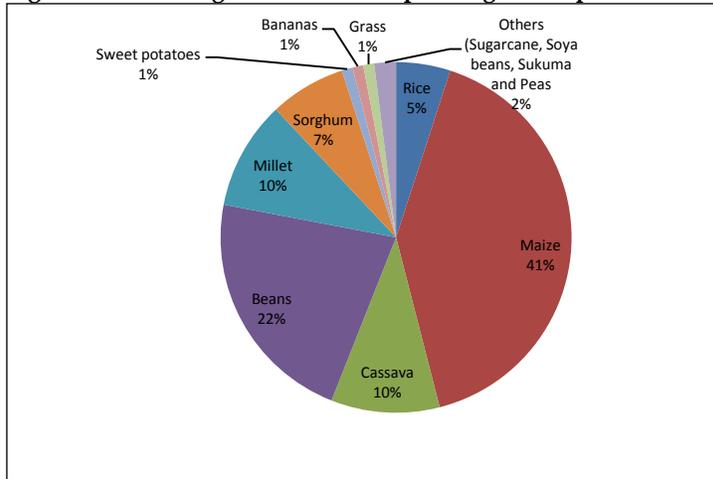
In the project area, residents earn their livelihoods from diverse economic activities including farming, employment (civil servant, teacher), trading, fishing and doing other jobs including electrical, motorcycles (Bodaboda) and security. The commonest source of livelihood is farming (70%), followed by fishing and trade (11% each) and employment (4%) as presented on **figure 16** below.

Figure 16: Average monthly income per Household by economic activity



Source: Field assessment

Figure 17: Percentage of households planting the crop

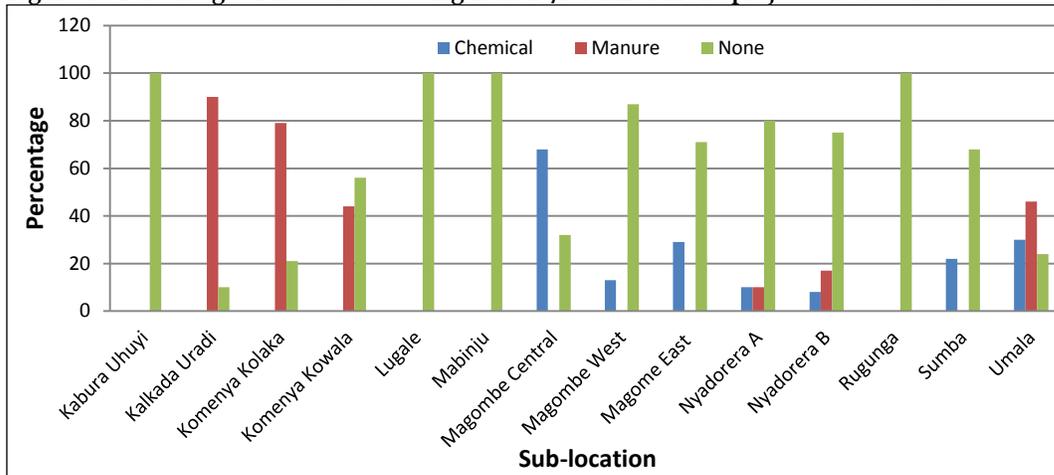


Source: Field Assessment

Food in the area is mainly stored on-farm in traditional granaries and/or off-farm in National Cereals and Produce Board (NCPB). The total population working in the agriculture sector is over 80%. Crop farming is faced with few challenges like flooding that destroy crops.

In the project area, household interviews revealed that a large proportion of people (69%) do not use any fertilizer. Further most households use manures (22%) than those who use chemical fertilizers (9%).

Figure 48: Percentage of households using manure/fertilizer in the project sub-locations



Source: Field Assessment

There is more use of chemical fertilizer in Magombe Central location while manure is commonly used in Magombe West, Komenya and Kowala and majority of the people in Lugale location do not apply either manure or chemical fertilizer.

Table 18: Cropping calendar

Crops	Jan	Feb	Mar	April	May	June	Jul	Aug	Sept	Oct	Nov	Dec
Maize												
Cotton												
Finger Millet												
Sorghum												
Paddy												
Horticulture												
Fruit tress												
Napier grass												
Cassava												
Sweet potatoes												
Pulses												

Source: Feasibility Study Report.

6.3.4.2 Livestock Keeping

Local breeds make up most of the livestock with the main animals kept in the project districts being Zebu, dairy cattle, goats and local poultry. Other livestock are also reared in the districts including sheep, pigs and rabbits. Livestock products in the project districts include milk, beef, mutton, poultry meat, egg, honey and pork. In the past, land was plenty and animals were left to graze freely. However, with reduced land availability, animals are tied up to graze in small grassy areas or kept at home for zero-grazing. The average family in the 2 districts has only 3 cows.

In the project area, domestic animals found to be most common are chickens followed by cattle, goats, ducks and sheep as presented in the **table 19** below.

Table 19: Domestic Livestock in the area

Livestock	Total number from household survey	Number per household
Cattle	396	2.6
Goats	194	1.3
Donkeys	13	0.1
Sheep	91	0.6
Pigs	36	0.2
Rabbits	8	0.1
Chickens	1041	6.9
Ducks	121	0.8
other poultry	226	1.5

Source: Field Assessment

Culturally, livestock plays a very important role in the study area including production of milk, dowry, meat, gifts for funerals, and these acts as a savings. Livestock is mostly grazed on the natural grassland or fallow field after harvest and managed using traditional techniques. The livestock is also grazed in the wetland areas especially as the floodwaters recede or during exceptionally dry years when the swamp areas shrink i.e. during the period when the Lake Victoria level fell substantially leaving the fringes dry.

6.3.4.3 Fishing

Fishing is traditionally practiced among the lakeshore communities (Luos) and could be found along the Lake Victoria, Lake Kanyaboli, and River Nzoia and within the

wetlands. It is an activity that provides an exit option for local communities when the local farming activities are depressed. Within the project area fishing is mainly done in the lake but also along the Nzoia River and the wetlands such as Sifuyo and Mahawa swamps on the right/left bank of River Nzoia. These are second to agriculture apart from petty trade and remittance from those working outside the area.

The Luos and the Abanyala; who in many cases share traditional practices pertaining to fishing which include, men's dominance in the physical removal of the fish in the said water bodies and women basically does the sales. There are no organized organizations that facilitate the sale of the fish; hence the middlemen expose fishermen to exploitation.

The major nearby fish collection and sales points include Sio Port and Port Victoria. The project area is characterized by a number of water ponds of different sizes and which as suggested could be transformed into fishponds. The project could also encourage this attribute by increasing the number of ponds. This will contribute in meeting ever-increasing demand for fish.

The common fish species catch being *Oreochromus Osculentus* (*Ngege*), Catfish (*mumi*, Nile perch, Omena, and *Protopterus acthiopus* (*kamongo*). In 2008, there were 3364 fishermen who mostly composed of strong energetic men leaving agriculture for the old men, women and children hence creating food insecurity. Land beaches are 18 and total Production from Capture Fishery was 62,469 metric tonnes which fetched Kshs. 59,325,642.

6.3.4.4 Sand Harvesting

Brick making/granite mining and sand harvesting is observable along the road reserves, wetlands and on arable cropland normally carried out by men. The sand harvesting is mainly carried out in specific pockets of the river which include; Wadh Mbare and Ajuke in Simur Kondiek sub-location, Adeda, Nyadenda and Lwanga in Siranga sub-location, Central Ugenya has 6, 3 places in West Ugenya location while Bunyala North and Khajula locations have 4 each. It is an activity mainly for the youth though it is hampered by poor state of roads.

6.3.4.5 Brick Making

The study area is endowed with black soils that enhance brick making, though the product is minimally utilized exclusively within neighbouring towns such as Kisumu, Siaya, Mumias and Busia. Houses, institutions and offices built out of bricks are less than 20% where as a greater percentage are semi permanent. This occupation though helps the community members. However, when put together with the need for firewood for basic cooking, brick making activity causes a concern of deforestation that should be addressed within the context of the project development. Energy saver 'Jikos' are not in use except in West Ugenya location where it is being introduced.

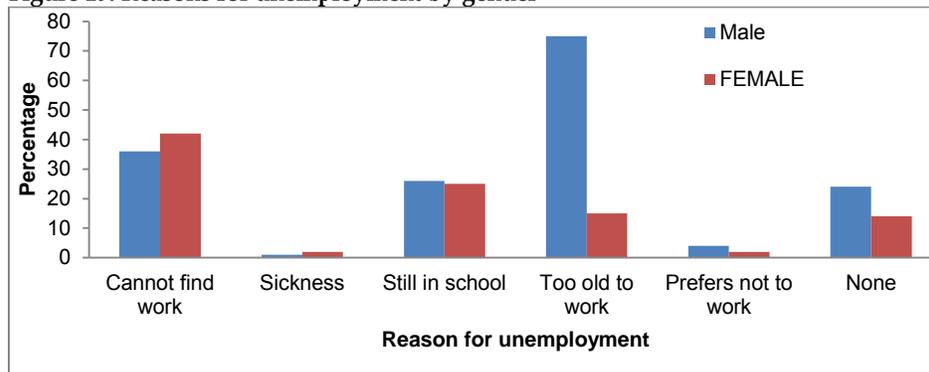
6.3.4.6 Employment

The labour force (15-64) in the two districts in 1999 was 280,298 (Bunyala 25,182 and Siaya 255,116) and is expected to continue increasing. Over 70 percent of labour force is engaged on family farms. The remaining over 25 per cent is distributed over other

economic activities such as fishing, trading and employment in the formal and informal sectors. The rate of unemployment in the districts is 73 percent.

The household survey revealed that 52% of the males and 48% of the females in the project area were unemployed. Majority of those employed worked in Nairobi (23%) followed by Mombasa (15%) and Kisumu (14%) while the rest worked in various other towns. The reasons advanced for unemployment included: cannot find work (39%), Sickness (2%), still in school (26%), too old to work (11%) and prefers not to work (3%) while the rest did not give reasons for not being in a gainful employment. **Figure 19** below presents an overview of reasons for unemployment in the project area.

Figure 19: Reasons for unemployment by gender



Source: Field Assessment

6.3.5 Health

6.3.5.1 5.3.5.1 Diseases

The commonest diseases in the project area was malaria accounting for 58% of the morbidity rates, followed by Diarrhoea (23%), Cholera (7%) and others (TB - 5%, Typhoid - 4% and HIV/AIDS - 3%) order of prevalence as shown in the figure 16 below. Many of these diseases are water related. The project area lies between Siaya and Bunyala districts each having specific backgrounds to disease outbreaks and prevalence. The life expectancy in Siaya is 36.9 and 43 years for male and females respectively while it is higher in Bunyala standing at 40 for males and 46 years for females.

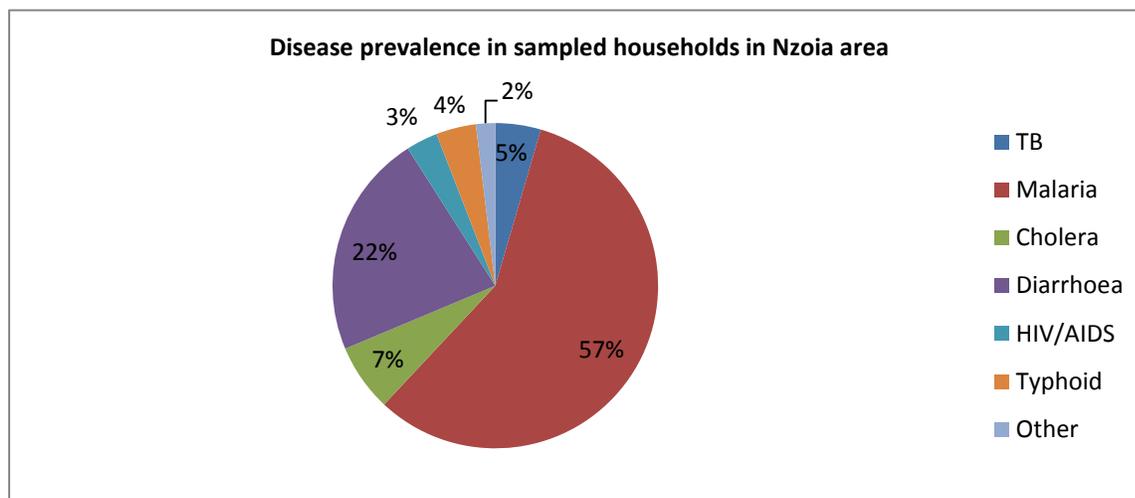
In Bunyala District, according to the Regional Assessment Team from Kenya Food Security Steering Group (KFSSG), in 2007 the district immunization coverage was 70.1%. Floods along the Nzoia river basin increase the cases of water-borne diseases such as cholera and increase the breeding grounds for mosquitoes leading increased cases of malaria. Flooding also leads to outbreaks of livestock diseases. The district also has latrine coverage of 46% according to KFSSG (2007) which poses a serious health hazard due to contamination of underground and open water sources from solid and waste disposal.

HIV/AIDS prevalence rates in the districts are 19.2% (15.4% in Bunyala and 24% in Siaya district). Thus implies that HIV/AIDS is a major health concern in the project area. The project area experiences annual flooding which brings many water borne

diseases that attacks the already weakened immune system. Flooding means the loss of crops, creating hunger. Other factors contributing to rapid spread of HIV/AIDS are:

- Engaging in unprotected sex
- Ignorance on safe sex practices
- Unwillingness to use condoms
- Ignorance on HIV status
- Commercial sex workers
- Extensive traditional use of herbal medicine.
- Negative cultural beliefs and unhygienic practices that facilitate the spread of HIV/AIDS including deliveries routinely performed by Tradition Birth Attendants and wife inheritance and/or sharing amongst age mates

Figure 20: Disease prevalence in the area



Source: Field Assessment

6.3.5.2 5.3.5.2 Health Facilities

The project districts have 78 health facilities (Bunyala 7 and Siaya 71) including hospitals, health centres, nursing homes, dispensaries and clinics. These are either public or private. The districts have 19 Voluntary Counselling and Testing (VCT) centres and 20 facilities offering Antiretrovirals (ARVs).

6.3.6 Transportation and Communication

The area is served with all-weather road are impassable during rainy season. Matters become worse when Nzoia River breaks its banks causing severe flooding that render the roads unusable and delinking areas like Mau Mau from the rest of other areas. The length of roads (earth, murrum, bitumen etc.) in both districts is tabulated below.

Table 20. Length of roads in Siaya and Bunyala districts

District	Nature of road (Kms)			Total
	Bitumen	Murrum/ Earth	Gravelled	
Bunyala	0	92	-	92
Siaya	97.9	667.2	400	1165.1
Total	97.9	759.2	400	1257.1

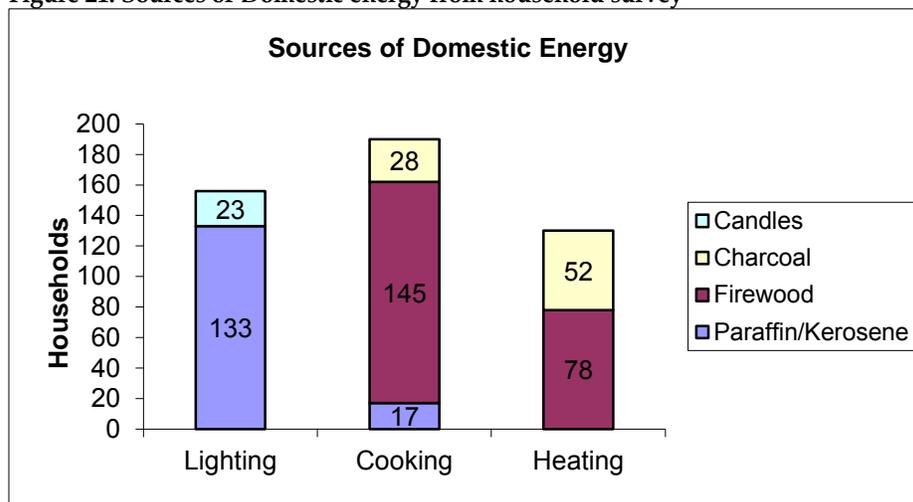
Source: Siaya and Bunyala District Development Plans, 2008-2012

Other transport infrastructure includes airstrips, waterways (only in Bunyala) and railway (only in Siaya district). The main communication facilities in the districts include mobile phone, post /sub post offices, telephone booth, private courier services, radios and cyber cafes.

6.3.7 Energy and Domestic Water Sources

The major energy sources within Siaya and Busia Districts with respect to quantity are fuel wood, paraffin, petroleum gas and electricity. Charcoal is the most popular within the urban centres such as Busia and Siaya Township; this is also mirrored by the upcoming urban centres (Figure 21).

Figure 21: Sources of Domestic energy from household survey



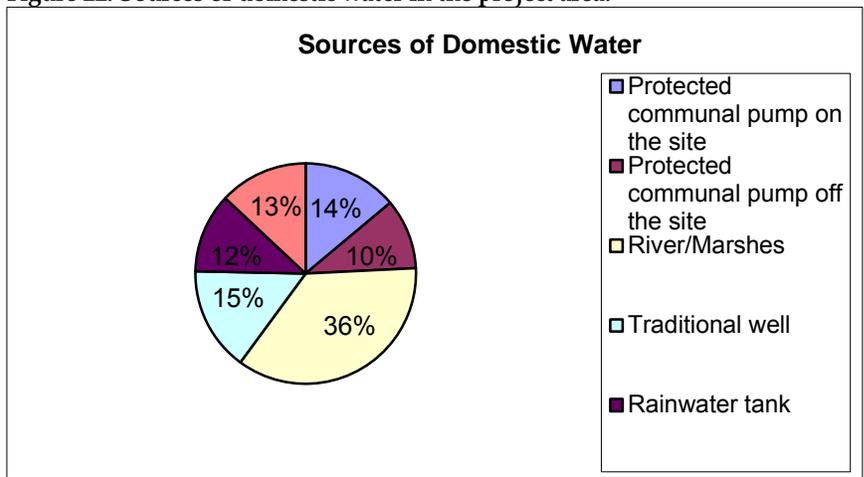
Source: Field Assessment

The main source of energy in rural Kenya today, inclusive of the Nzoia river basin is wood fuel. It is used for all the basic rural energy requirements, apart from Kerosene, which is used for lighting within most of the rural homes.

The principle sources of domestic water for drinking and cooking are wells and bore holes. Lake water is primarily used for recreation and fishing while Nzoia river water is used for washing and irrigation. The river and its tributaries provide permanent water but with varying flows through the seasons of the year. Major water reticulation systems in this region are found in urban centres abstracting water from the river and its tributaries. This shows that the Nzoia flood plain has good water resources that can be used in a sustainable way.

The major water reticulation systems are only available in the urban centres abstracting water from the river and its tributaries. Otherwise water reticulation schemes for the rural masses are few. The bigger hindrance to this development is the high cost of operation and maintenance. The organizational capacity of the rural masses in this respect is also in doubt. It was however observed that shallow wells exist within the study area. For the potential selected irrigation area, therefore water for human consumption should be an important consideration with respect to quality and quantity. Information from the household survey was used to plot the pie chart in **figure 22** below.

Figure 22: Sources of domestic water in the project area.



Source. Field Assessment

6.3.8 Water Access and Sanitation

The study area is relatively well endowed with water resources. The water sources in the study area include River Nzoia and its tributaries, swamps, few earthen dams on the tributaries and potential for ground water, Nzoia being the largest. The average distance to the nearest potable water point for many is within 2 km. Investigations revealed that the water is basically used for domestic use, drinking for both humans and livestock and about 3% of the population use it for irrigation of crops especially horticultural crops. Piped water is available only within the urban centres and effort should be made to extend this benefit to the rural areas. This would bring direct benefit to the women who otherwise must make a choice between the effort and time involved in fetching and boiling water or facing the risk associated with consuming untreated and boiled water.

It was established that all locations have an average of 10 shallow wells because the Government and NGOs are promoting safe water supply in the area. There are few piped water systems in the area i.e. townships and only in West Ugenya location and Bunyala North location. Other sources include ponds, springs and rain water. It should be noted that relatively good impression was obtained on the enthusiasm of the inhabitants of the project area on utilization of river Nzoia water for irrigation.

A number of households still lack sanitation facilities (latrines, toilets) due to poverty and presence of alternative defecating areas (bushes). This constitute one of the principal pathways for infection which can kill people once the human wastes are swept by running water into the water bodies. This is coupled to the notable long distance to health centres.

6.3.9 Education and Literacy levels

The project districts have a total of 1072 education institutions (pre-primary schools – 455, primary schools – 425, secondary schools – 118, other training institutions – 8 and adult classes 66). Majority of these are located in Siaya district. Literacy levels are higher in Siaya (78.2%) than in Bunyala (62.5%) district. In both districts, literacy levels for males (81.6%) is higher than for females (59.9%) as presented in the **table 21** below.

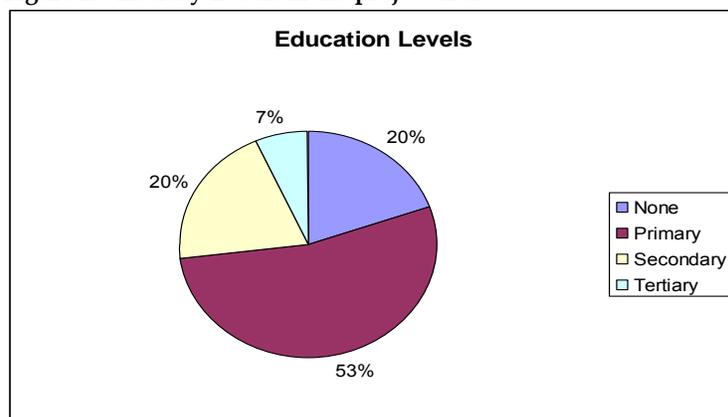
Table 21: Education institutions and literacy levels in project districts

Type of institution	Number of institutions per district		Total	
	Bunyala	Siaya		
Number of educational facilities	Number of pre-primary schools	28	427	455
	Number of primary schools	34	391	425
	Number of secondary schools	7	111	118
	Number of other training institutions:	4	4	8
	Number of adult classes	18	48	66
Literacy levels (%) by sex	Male	73.9	89.2	81.6
	Female	51.1	68.7	59.9
	Total	62.5	78.2	70.4

Source: Siaya and Bunyala District Development Plans, 2008-2012

The household assessment results showed that majority of the population (53 % have at least attained primary school level. However, there were a small percentage of these proceeding to secondary (20%) and even fewer reaching tertiary institutions (7%). The remaining 20% was found to formal education (**figure 23**).

Figure 23: Literacy Levels in the project area



Source. Field Assessment

6.3.10 Gender and Inequality

50.4% of all households in Siaya are female headed households while children headed households are 4.4%. Bunyala district has 13,749 households of whose average size is

4.5%. The high number of female headed households may be explained by single parenthood and high male mortality rates.

Gender roles related to livelihood activities were also very clear. For instance, land preparation, maintenance of water levels and cutting of rice stalks is done by men, while both genders could do land-levelling and bird scaring. Women exclusively do transplanting, weeding, and threshing. In all other farming activities, a similar trend is duplicated, with men doing the harder manual work such as clearing and ox-ploughing, while women did hand digging, planting, weeding and harvesting. Men are also employed in construction sites and digging of water channels. Weaving and livestock rearing is done by both gender, even though men also do undertaken spraying of cattle or take to the dip. Very few of both genders from the same household are involved in formal employment.

6.3.11 Culture

There are more than 40 tribes living in Kenya and most them are found in the project's command area due to socioeconomic activities in the area. The common tribes of the area are Luos, Tesos and Luhyas. They are engaged in small scale farming, fishing along Lake Victoria and small business. Most of the people live in small villages. Some of the cultural sites identified in the wider project area are listed in **Annex D** of this report.

6.3.12 Security

There are common incidences of insecurity in the project area. This insecurity is in the form of cattle rustling and political clan rivalry among others.

6.3.13 Poverty

The project area lying between Siaya and Bunyala districts faces deprivation associated with poverty that is characteristic throughout the two districts. The Lower Nzoia basin straddles the Siaya and Busia districts both of which have 60-70% of their population living below the poverty line.

The KIHBS 2005/06 revealed that the absolute poverty in Siaya district was 39.3% (Rural 40% and Urban 38.6%) with Food Poverty being 34% and the district contributed 0.013% to National poverty. The absolute poverty in Bunyala district was 68% while food poverty was 62% and the district's contribution to national poverty was 2.43%. Bunyala district has 50.5% male and 49.5% of females who are poor while similar figures for Siaya district are 46.9% male and 50.7% of females (CBS, Well Being in Kenya – A socio-Economic Profile, 2008).

There are many factors that have caused poverty to spread including population growth, shifting land use systems and ownership from common to individual, pressure on natural resources such as trees (for firewood and building), deforestation leading to soil erosion and desertification and a decrease in soil fertility. Other causes include increasing expenditures on education and healthcare. Though there are many development initiatives in the project area, poverty is still a major challenge. Most families live on less than a dollar a day. Poverty hits hardest in areas facing low rainfall levels and poor soil fertility, such as the lower Ukwala, Uranga and Karemo divisions.

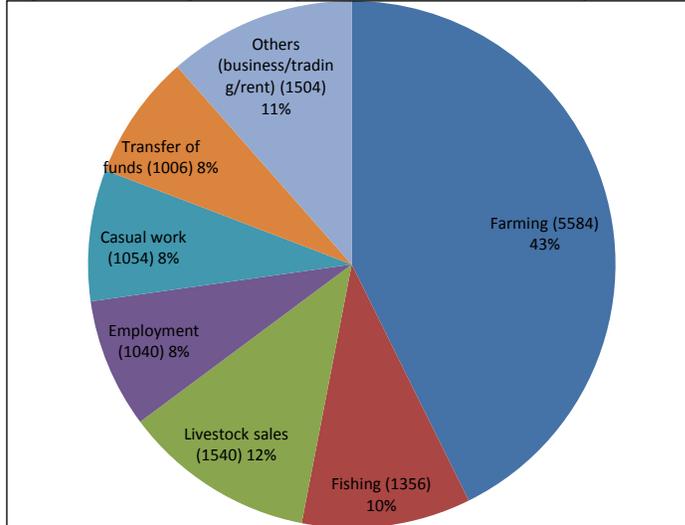
According to the household survey the main challenges that the residents around the project area face are food shortages, education and fees, money and income, clothing, diseases and healthcare facilities shortages, shelter and employment, in respective order of magnitude.

6.3.14 Income

Agriculture is the most adopted means of livelihood and as such it’s the highest source of income in the area at 43% followed by livestock keeping and fishing as shown on figure 24 below.

The average monthly income for the household head is Kshs. 5,200. The survey that was conducted during design indicated that farm incomes from crops the previous year was Kshs. 16,108 that translated to approximately Kshs.1, 300 per month. The average annual income from livestock and agricultural wages was Kshs. 13, 571(Kshs.1, 100) per month. This depicts that for the bigger populace crop production generate more income compared to livestock. However, it was noted overall annual income was generally low. Only a small percentage 4% indicated have permanent jobs with an average income of Kshs. 61,019, while over a quarter 28% had small scale business with average annual income of Kshs. 15,566. By and large, farming and other agricultural related activities are more important as a source of income for the local community and should be given more emphasis for the development of the area. Most expenses go to education which has a mean of Kshs. 8,538 per month.

Figure 24: Average monthly income per Household by economic activity



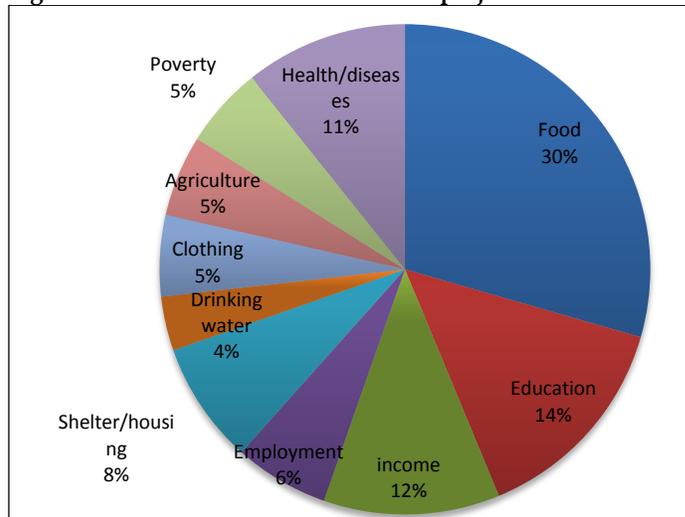
Source. Field Assessment

6.3.15 Challenges and needs in the project area

Prioritization of needs and assessment of coping mechanisms was conducted to assess the values locals attached to various issues, specifically agriculture. From the interviews conducted, food is the major challenge/need accounting for 30% of all the needs. This is closely followed with education, incomes and health respectively. The irrigation project aims at primarily addressing the two issue of food security (30%) by extension poverty

(income and employment - 18%) and agriculture (5%) which combined accounted for 53% of all the needs in the project area. This is a clear justification for the project implementation.

Figure 25: Prioritization of needs in the project area



Source: Field Assessment

Residents in the project area have adopted various strategies to cope with each of the above needs as follows:

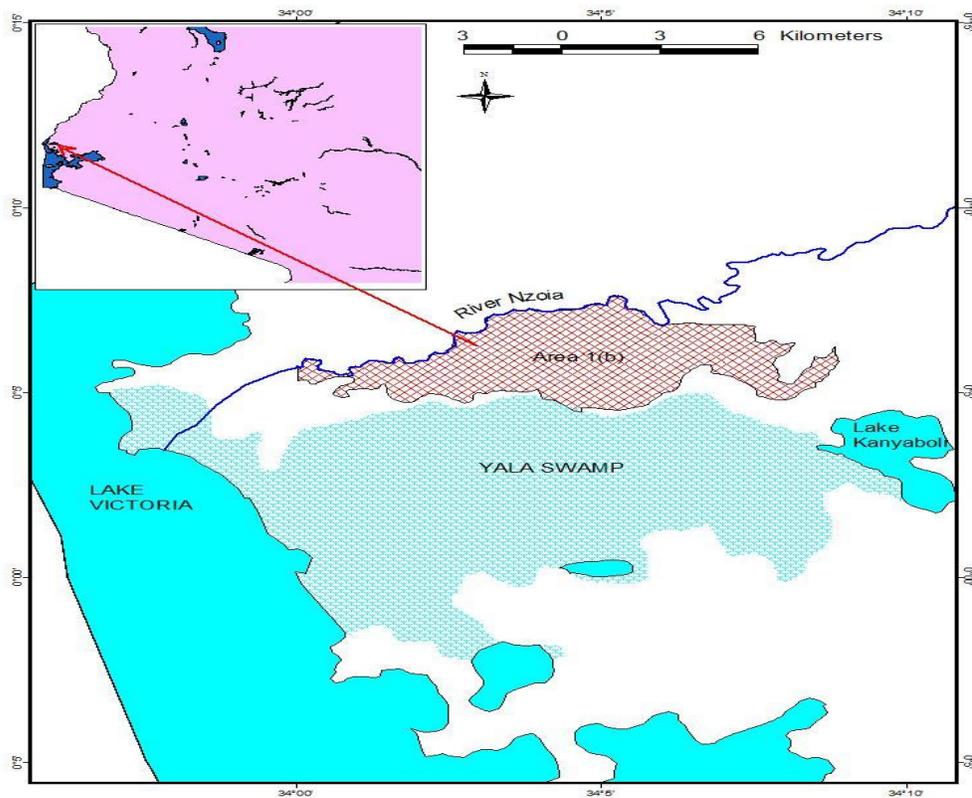
- Health- visiting the local clinic, taking medicine or going to a doctor, using Herbal medicine, using NHIF funds, maintaining healthy standards and doing without medicine when on falls sick
- Education - Seeking assistance from schools, letting children dropout of school, borrowing from friends/relatives, getting Bursaries/community raise fees/harambee, assistance from charitable institutions and paying fees in bits
- Employment - doing casual work
- Food - engaging in farming, Buying food, relying on relatives, diversifying crops grown, growing resistant crops and depending on food aid form GOK and NGOs
- Poverty, Income and employment- engage in business activities or casual labour to generate income, Pray to God, foregoing non-basic necessities and borrowing from neighbours
- Other strategies are getting loans from society, engaging in income generating activities and relying on children and handouts from relatives
- Water - boil water, using untreated/unsafe water and searching long distances for water
- Shelter and housing - constructing more houses as a preferred strategy and living/sharing their houses with their livestock.
- Agriculture (labour, ploughing and inputs shortages in farms) - use hand digging, local seeds and relying on family labour.
- Clothing - buy second hand clothes.

6.4 SENSITIVE ECOSYSTEM

6.4.1 Yala Swamp

The Yala Swamp is south to the project area and bounded to the north by the Nzoia River and to the south by the Yala River. The swampland covers an area of about 17,500 hectares (ha) in Siaya, Bondo and Busia district that is home to nearly 1.2 million people. This is Kenya's largest wetland, a very delicate ecosystem, and the habitat of some rare flora and fauna, including endangered fish species. The swamp serves the adjacent communities as a source of fish, water, agricultural land, pastures, wild animals, plants for constructing houses, source of wood fuel and medicinal plants.

Figure 26: Yala swamp location relative to the project area



6.4.2 Nzoia River

The meandering of River Nzoia has created swampy areas along its banks. These swamps are a source of fish, water for irrigation and natural products that are harvested by local community. Mud fish is common in these flooded areas and provide a source of nutrition. Papyrus is also harvested for mat making and thatching of houses as well as weaving baskets which is sold for income by both men and women.

6.5 ENVIRONMENTAL AND SOCIAL TRENDS

6.5.1 Poverty

The project area lying between Siaya and Bunyala districts faces deprivation associated with poverty that is characteristic throughout the two districts. The Lower Nzoia basin

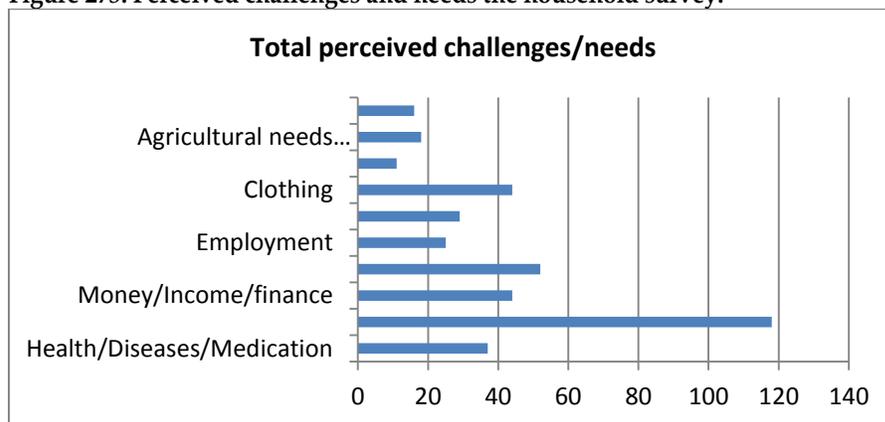
straddles the Siaya and Busia districts both of which have 60-70% of their population living below the poverty line.

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According to the household survey the main challenges (**figure 27**) that the residents around the project area face are food shortages, education and fees, money and income, clothing, diseases and healthcare facilities shortages, shelter and employment, in respective order of magnitude.

Figure 275: Perceived challenges and needs the household survey.



Kristjanson P., Krishna A., Radeny M. & Nindo W. in the study *Pathways out of Poverty in Western Kenya and the Role of Livestock* (2004) by International Livestock Research Institute (ILRI) describe Siaya District as having 47% percent of its population below the rural poverty line in 1994 and this increased to 64 percent in 1999. They then add that in the last 25 years (since 2004) that 8% percent of households climbed out poverty while 25% percent became impoverished during the same time. The main strategies from their survey for escaping poverty (poverty eradication) include diversification of income, diversifying on farm income through cash crop production and livestock ranging from cattle to poultry. The main reason in their findings for households falling into poverty

was poor health and the high cost health related expenses which was the case in 77% of the households they surveyed in Siaya. They also find that the four main reasons for household remaining poor are poor health and related health expenses, heavy funeral expenses, low level of education and unproductive land.

Bunyala district which formerly part of Busia district has high poverty levels of 64% which when coupled with the HIV prevalence rate threaten food security in the district (KFSSG, 2008). There are not many studies on the poverty levels, causes and maintaining factors in Bunyala District however it shares similar characteristics with the surrounding districts of Busia and Siaya and this also presents an opportunity for a comprehensive study to be carried out in the wider Bunyala district.

There are a number of poverty eradication schemes in the two districts and the rice irrigation scheme by National Irrigation Board is one of them in Bunyala district. There is pressing need to eradicate poverty in the area to improve standards of living, agricultural productivity, food security and general wellbeing of the people.

6.5.2 Population Increase

According to the latest national household and population census (1999) the total number of people and households within the Lower Nzoia Basin, the project area is estimated at 183,312 and 37,859 respectively. The average annual growth rate in the area is about 3%. The population census gives the working population on family farms (15-64 years old) in the country as about 74 % of the total population. This means that 3.9 persons are available for family labour on an average (116,156 persons/21,891 households x 74% = 3.9 persons/household).

With improved food security, improved infrastructure and resources to improve them, creation of employment and socio-economic improvement that can result from the project then it is expected that population will increase by reducing infant mortality, increasing life expectancy and people will migrate into the area in seek of employment.

6.5.3 Soil Erosion

The types of soil that exists in some parts of the project area particularly the downstream region of Nzoia River is a major contributor of increased floods. The existing soil does not allow water to drain easily so the soil becomes waterlogged leading to flooding. Due to frequent flooding, soil erosion occur leading to the top fertile soil being washed away to other areas. People living in the area have experienced erosion problems along the riverbanks, drains along the roads, and in canals and drains associated with the Budalangi Rice Scheme.

6.5.4 Deforestation

Deforestation in the upper catchment leading to degradation of forests is common, and is a major contributor to increased flooding in the downstream region of Nzoia River. The situation is worsened by the absence of vegetation that used to lower the speeds of running flood water upstream leading to excess water flowing into River Nzoia, causing it to burst its banks and result in floods.

6.5.5 Floods

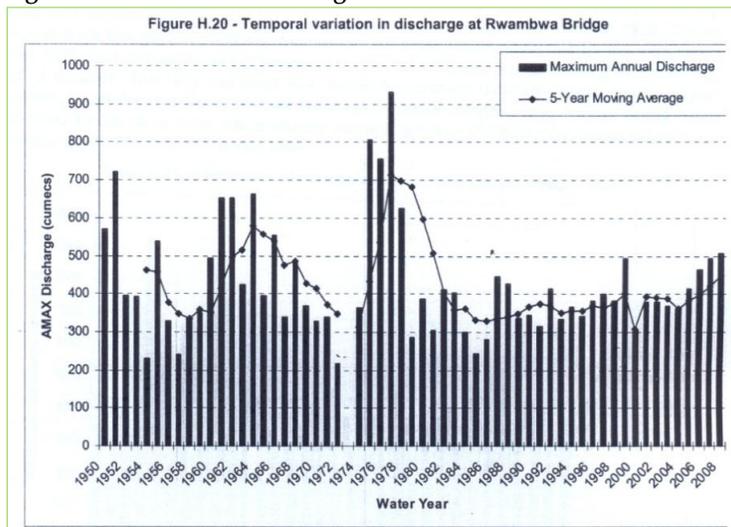
Heavy rain falls in the upper catchment areas coupled with the decreased vegetation to intercept and increase rainfall water infiltration leads to the increase in runoff hence increasing the volume of water in the Nzoia River consequently flooding in downstream areas.

The major causes of flooding in Lower Nzoia region are meanders developed on the Nzoia River that cause its discharge rates to reduce due to reduction in the river velocity and thus leading to the river bursting its banks and flooding the lower areas. Other factors include deposition of silt at the mouth of River Nzoia at the Sango area, soil types of the region does not allow water to drain easily and fast enough, old dykes and the general geographical formation of the area.

Dykes have been built to help control the floods but in some cases they prevent draining of water into the river hence also causing floods. River flow gauge on the Nzoia River is located at Rwambwa Bridge. A 58 year flow record shows that the river flow is characterized with bimodal distribution, with two discharge peaks each year. The peaks occur during the long rains (March/May) and short rains (late August/ November).

The **figure 28** below shows the annual maximum discharge with a five year moving average. The graph shows that the three highest discharge peaks occurred at the beginning of the gauged record from 1975-1977 and the range of discharge was between 757-930m³/s. the discharge after 1978 was significantly lower. Trend showed by the graph suggests that there were high flows during 1950s which fell and begun picking up in early 1960s. From the graph below, it appears that the maximum discharge has been increasing slowly over the last two (2) decades. This comes out clearly as shown by the graph from year 2004. High flow peaks in the 1970 could be explained by the fact that rating curve at Rwambwa Bridge was changed from 1979. The previous rating curve was much flatter and was changed from 1979.

Figure 28: Variation in discharge at Rwambwa station



6.5.6 Irrigation

There are a number of irrigation schemes in the project districts including Bunyala Rice Scheme, Rwambwa Mudembi, Nahasyongo Muluwa, Muuri, Neboka, Bubasi, Munaka, Yala Swamp, Syamungu and Busagwa. In the project area the major existing irrigation scheme is the Bunyala irrigation scheme (280ha) which is under the management of the NIB. Because of the presence of the scheme in the area, farmers within the vicinity have developed interest and the scheme has expanded to covering mudembi (Mudembi irrigation, which is being developed with the assistance of NIB and Plan International, an NGO) and Muluwa areas (Anyiko) which has expanded the coverage area to over 300ha. Bunyala irrigation scheme was also developed as pilot scheme and abstracts water from River Nzoia through pumping.

Altogether these schemes are currently cultivating about 700 acres of rice but at different times of the year. Both the scheme farmers (about 132 households) and out-grower farmers (about 620 families) grow rice and rice irrigation is ranked as the first livelihood strategy in the area.

6.5.7 Human Wildlife Conflict

The lower reaches of the proposed irrigation area, experiences warthogs and hippopotamus invasion into the farms. Hippo families are found on the lower parts of Nzoia and Yala rivers and from Lake Vitoria wetlands and the adjacent Yala swamp. This occasional invasion has created human wildlife conflict in the area.

6.5.8 Farming in Flooded Areas

Flood water of Nzoia River carry silt from the catchment and deposits this silt in the flood plain areas and the banks of the river channel. The presence of water and fertile grounds caused by the silt has lead to cultivation of these marginal areas by the local population.

7 POLICY, LEGAL AND INSTITUTIONAL FRAMEWORK

This section of the report outlines and reviews the existing legislations, policies and institutions and identifies requirements as well as gaps and conflicts of the relevant legal and institutional arrangements that would hinder or guide the development of the project in line with the national and international laws applicable to irrigation. Kenya being a signatory to various international conventions and laws, it's important that national projects are in line with these laws and as such some of the relevant international conventions are reviewed in this chapter.

7.1 LEGISLATIVE FRAMEWORK

7.2 THE CONSTITUTION OF KENYA

Section 69 of the Constitution part (a) ensure sustainable exploitation, utilisation, management and conservation of the environment and natural resources, and ensure the equitable sharing of the accruing benefits; (f) establish systems of environmental impact assessment, environmental audit and monitoring of the environment; (g) eliminate processes and activities that are likely to endanger the environment.

7.3 ENVIRONMENTAL MANAGEMENT AND COORDINATION ACT, EMCA 1999

This is an Act of Parliament that provides for the establishment of an appropriate legal and institutional framework for the management of the environment. Prior to its enactment in 1999, there was no framework environmental legislation. Kenya's approach to environmental legislation and administration was highly sectoral and legislation with environmental management components had been formulated largely in line with natural resource sectors.

EMCA (1999) was developed as a framework law, and this is due to the fact that the Act is thus far, the only single piece of legislation that contains the most comprehensive system of environmental management in Kenya. The Act provides for the establishment of an appropriate legal and institutional framework for the management of the environment in Kenya and for matters connected therewith and incidental hereto. The Act is based on the recognition that improved legal and administrative co-ordination of the diverse sectoral initiatives is necessary in order to improve national capacity for the management of the environment, and accepts the fundamental principle that the environment constitutes the foundation of our national, economic, social, cultural and spiritual advancement.

Section 3 of the Act enunciates the General Principles that will guide the implementation of the Act. Every person in Kenya is entitled to a clean and healthy environment and has the duty to safeguard and enhance the environment. It is worth noting that the entitlement to a clean and healthy environment carries a correlative duty. Hence, there is not only the entitlement to a clean and healthy environment, but also the duty to ensure that the environment is not degraded in order to facilitate one's own as well as other persons' enjoyment of the environment.

EMCA section V provides for the protection and conservation of the environment especially in the case of rivers, lakes or wetlands in all processes of irrigation development. It states that an environmental impact assessment must be undertaken when erecting, reconstructing, altering, extending, removing or demolishing any structure or part of any structure in, or under the river, lake or wetland. All irrigation developments fall under the 2nd schedule and these are agricultural projects that must require an EIA before commencement.

Environmental (Impact Assessment and Audit) Regulations 2003

The Environmental (Impact Assessment and Audit) Regulations 2003 state in Regulation 3 that “the Regulations should apply to all policies, plans, programmes, projects and activities specified in Part III and V of the Regulations” basically lists the guidelines of undertaking, submission and approval of the ESIA Reports.

Environmental Management and Co-ordination (Waste Management) Regulations 2006

These are described in Legal Notice No. 121 of the Kenya Gazette Supplement No. 69 of September 2006. These Regulations apply to all categories of waste as provided in the Regulations. These include:

- *Industrial wastes;*
- *Hazardous and toxic wastes;*
- *Pesticides and toxic substances;*
- *Biomedical wastes;*
- *Radio-active substances.*

The proposed Project will have to abide by these regulations in dealing with waste management especially the provisions of wastes which may be generated during their construction and operation phases of the sub project investments. Pesticides may also be used under the irrigation related components of certain sub projects and as such the regulations on the disposal of pesticide wastes must be adhered to.

Environmental Management and Coordination, (Water Quality) Regulations 2006

These are described in Legal Notice No. 120 of the Kenya Gazette Supplement No. 68 of September 2006. These Regulations apply to drinking water, water used for agricultural purposes, water used for recreational purposes, water used for fisheries and wildlife and water used for any other purposes. This includes the following:

- *Protection of sources of water for domestic use;*
- *Water for industrial use and effluent discharge;*
- *Water for agricultural use.*

These Regulations outline:

- a) *Quality standards for sources of domestic water;*
- b) *Quality monitoring for sources of domestic water;*
- c) *Standards for effluent discharge into the environment;*
- d) *Monitoring guide for discharge into the environment;*
- e) *Standards for effluent discharge into public sewers;*
- f) *Monitoring for discharge of treated effluent into the environment.*

In fulfilling the requirements of the regulations the project proponent will have to undertake monitoring of both domestic water and wastewater and ensure compliance with the acceptable discharge standards.

Environmental Management and Coordination, Conservation of Biological Diversity (BD) Regulations 2006

These regulations are described in Legal Notice No. 160 of the Kenya Gazette Supplement No. 84 of December 2006. These Regulations apply to conservation of biodiversity which includes Conservation of threatened species, Inventory and monitoring of BD and protection of environmentally significant areas, access to genetic resources, benefit sharing and offences and penalties.

Environmental Management and Coordination (Fossil Fuel Emission Control) Regulations 2006

These regulations are described Legal Notice No. 131 of the Kenya Gazette Supplement no. 74, October 2006 and will apply to all internal combustion engine emission standards, emission inspections, the power of emission inspectors, fuel catalysts, licensing to treat fuel, cost of clearing pollution and partnerships to control fossil fuel emissions used by the Contractor. The fossil fuels considered are petrol, diesel, fuel oils and kerosene.

Environmental Management and Coordination (Wetlands, Riverbanks, Lake Shores and Sea Shore Management) Regulations 2009

These regulations provide for the protection and management of wetlands, riverbanks, lakeshores and sea shore management and detail guidelines on the same.

Environmental Management and Coordination (Noise and Excessive Vibration Pollution) (Control) Regulations, 2009

These regulations prohibit making or causing any loud, unreasonable, unnecessary or unusual noise which annoys, disturbs, injures or endangers the comfort, repose, health or safety of others and the environment. It also prohibits the Contractor from excessive vibrations which annoy, disturb, injure or endanger the comfort, repose, health or safety of others and the environment or excessive vibrations which exceed 0.5 centimetres per second beyond any source property boundary or 30 metres from any moving source. Under the regulation the Contractor will be required to undertake daily monitoring of the noise levels within the Project area during construction period to maintain compliance.

7.4 WATER ACT

The Water Act is an act of parliament that provides for the effective management, conservation, use and control of water resources and for the acquisition and regulation of rights to use water; to provide for the regulation and management of water supply and sewerage services.

This Act establishes and provides legislative for the state run Water Resource Management Authority (WRMA) by stipulating the following:

- Water apportionment and allocation,

- Catchments protection and conservation,
- Water resource assessments and conservation,
- Delineation of catchments areas,
- Gazetting water protected areas,
- Protection of wetlands,
- Gazetting water schemes to be state and community owned,
- Establishing Catchments Management Strategies (CMS) and
- Collecting fees for water use and effluent discharges.

The Water Act 2002 also created the operations of WRMA which are carried out through six regional offices set up at river basin levels and is supported by Catchments Area Advisory Committees and Water Resource Users Associations (WRUA). The WRMA provides for community involvement in water resource management and in conflict resolution through the WRUA's by introducing a system of user fees to be levied on the abstraction and use of raw water to fund the costs for WRMA.

7.5 IRRIGATION ACT (CAP 347)

The NIB was established in 1966 through the Irrigation Act (Cap 347) of the Laws of Kenya. The Irrigation Act specifies the functions and powers of the NIB, its governance structure and financial provisions, and its corporate character. The NIB is incorporated as a non-profit generating corporate organization in the Ministry of Water and Irrigation. As a parastatal, the National Irrigation Board is also subject to the State Corporations Act which guides all state agencies in Kenya.

The Act gives the Minister power's to designate any area of land as a national irrigation scheme. Once an area is designated as such a scheme, the National Irrigation Board would be responsible for settling people on it and for administering it, including making arrangements for the supply of irrigation water to the scheme. Apart from irrigation carried out through designated irrigation schemes, private individuals engaged in irrigated agriculture are required to apply for, and obtain, a permit for water abstraction, following the permit application procedures that apply to abstraction for any other use.

7.6 AGRICULTURE ACT

The Agriculture Act Cap 318 of the Laws of Kenya seeks to promote and maintain a stable agriculture, to provide for the conservation of the soil and its fertility and to stimulate the development of agricultural land in accordance with the accepted practices of good land management and good husbandry.

7.7 THE PUBLIC HEALTH ACT (CAP 242)

The Public Health Act (Cap 242) aims at protecting and promotes human health and the prevention, limitation or suppression of infectious, communicable or preventable diseases within Kenya. This Act provides the impetus for a healthy environment and gives regulations to waste management, pollution and human health.

On sanitation, the Act borrows from the common law doctrine of nuisance which makes it an offence for any landowner or occupier to allow nuisance or any other condition liable to be injurious or dangerous to health to prevail on his land. A medical health

officer, once satisfied of the danger, may issue an order requiring the owner or occupier of the land to remove the nuisance. Any person who fails to clear such a nuisance is guilty of an offence under the Act. In addition, the Minister, on the advice of the Central Board of Health, may make rules and confer powers and impose duties for the carrying out of environmental health matters.

7.8 THE PHYSICAL PLANNING ACT

This Act provides for the preparation and implementation of physical development plans for any development or infrastructure. It establishes the responsibility for the physical planning at various levels of Government in order to remove uncertainty regarding the responsibility for regional planning.

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

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

7.9 LAND ACT 2012

The Land Act is Kenya's framework legislation regulating compulsory acquisition of real property (i.e. land, houses, easements etc.).

Actions preliminary to the Acquisition

Under the LA, the Government can carry out land taking for reasons of "defence, public safety, public order, public morality, public health, town and country planning or the development or utilization of any property in such manner as to promote the public benefit," and when such necessity justifies the hardship that the intended acquisition may cause to any person having interest in the land. The LA requires the Minister to be satisfied that such necessity exists before setting in motion the process and directing in writing to the National Land Commission to acquire the land compulsorily. Under the LA, public participation in eminent domain decisions is limited to the public hearing scheduled to determine legitimate claims, and the value of land and compensation. The opinion of the landowner on whether or not the government should acquire the land is not considered. Such objections by the owner are deemed irrelevant and it is an offense to wilfully oppose or impede the State's taking of the land.

7.10 OCCUPATIONAL HEALTH AND SAFETY ACT, 2007

This is an Act of Parliament to provide for the safety, health and welfare of workers and all persons lawfully present at workplaces, to provide for the establishment of the National Council for Occupational Safety and Health and for connected purposes. The Act has the following functions among others:

- *Secures safety and health for people legally in all workplaces by minimization of exposure of workers to hazards (gases, fumes & vapours, energies, dangerous machinery/equipment, temperatures, and biological agents) at their workplaces.*
- *Prevents employment of children in workplaces where their safety and health is at risk.*
- *Encourages entrepreneurs to set achievable safety targets for their enterprises.*
- *Promotes reporting of work-place accidents, dangerous occurrences and ill health with a view to finding out their causes and preventing of similar occurrences in future.*
- *Promotes creation of a safety culture at workplaces through education and training in occupational safety and health.*

Failure to comply with the OSHA, 2007 attracts penalties of up to KES 300,000 or 3 months jail term or both or penalties of KES 1,000,000 or 12 months jail term or both for cases where death occurs and is in consequence of the employer. The Occupational Safety and Health Act (OSHA) 2007 repealed the Factories and Other Places of Work Act. Anything done under the provisions of the Factories and Other Places of Work Act including subsidiary legislation issued before the commencement of the OSHA 2007 shall be deemed to have been done under the provisions of this Act.

The Factories and Other Places of Work Act had over the years passed several subsidiary rules and regulations for effective implementation of the Act. All shall, as long as it is not inconsistent with OSHA 2007 remain in force until repealed or revoked by subsidiary legislation under the provisions of OSHA 2007 and shall for all purposes be deemed to have been made under this Act.

These regulations include:

- *The Factories (Cellulose Solutions) Rules 1957;*
- *The Factories (Wood Working Machinery) Rules 1959;*
- *The Factories (Dock) Rules 1962;*
- *The Factories (Eye Protection) Rules 1978;*
- *The Factories (Electric Power) (Special) Rules 1978;*
- *The Factories (Building Operations and Works of Engineering Construction)*
- *The Factories and Other Places of Work (Health & Safety Committees)*
- *The Factories and Other Places of Work (Medical Examination) Rules 2005;*
- *The Factories and Other Places of Work (Noise Prevention and Control)*
- *The Factories and Other Places of Work (Fire Risk Reduction) Rules 2007;*
- *The Factories and Other Places of Work (Hazardous Substances) Rules 2007.*

The scope of OSHA 2007 has been expanded to cover all workplaces including offices, schools, academic institutions and plantations. It establishes codes of practices to be approved and issued by the Director, Directorate of Occupational Health and Safety (DOHS) for practical guidance of the various provisions of the Act.

Other parameters within the Act relevant to the project include:

- *Duties of employers, owners or occupiers of workplace;*

- *Establishment of safety and health committees;*
- *Annual safety and health audit of workplaces;*
- *Safety and Health obligations for persons who may come to premises for work and are not employees of that particular workplace;*
- *Reporting of any accident, dangerous occurrence or occupational poisoning caused in the workplace to the area Occupational Health and Safety Office. These incidents should be entered in the General Register. In case of fatal accident information to the area Safety and Health Office should be within 24 hrs. and a written notice to the same within 7 days;*
- *The duties of manufactures, designers, importers and suppliers to ensure that all articles and substances for use at workplace are safe and will not cause injury to health and the environment;*
- *Duties of self-employed persons;*
- *Duties of employed persons;*
- *Prohibition of interference or misuse of any appliance, convenience or any other facility provided to secure Safety, Health and Welfare at work by any person (occupier, self-employed person or employed);*
- *The administration of the Act is the responsibility of a Director and other appointed and gazetted officials (Occupational Health and Safety Officers);*
- *The registration of all workplaces by the Director Directorate of Occupational Health and Safety (DOHS) forming the basis of his work statistics;*
- *Machinery safety to include:*
 - *Safe use of machinery, plant and equipment;*
 - *Prime makers and transmission machines;*
 - *The maintenance, construction of fencing safeguards;*
 - *The statutory requirements of various machines, plants and equipment (hoists and lifts, chains and ropes, cranes, steam receivers and containers, air receivers, cylinders for compressed liquefied and dissolved gases and refrigeration plants).*

Chemical safety including:

- *Handling, transportation and disposal of chemicals and other hazardous substances;*
- *Importance of Materials Safety Data Sheets (MSDS);*
- *Labelling and marking of chemical substances;*
- *Classification of hazardous chemicals and substances;*
- *Establishment and adoption of exposure limits on hazardous substances in a workplace;*
- *Control of air pollution, noise and vibrations;*
- *Redeployment on medical advice.*

7.11 THE WILDLIFE CONSERVATION AND MANAGEMENT ACT, CAP 376

The Wildlife (Conservation and Management) Act, Cap 376 of 1976, as amended in 1989, covers matters relating to wildlife in Kenya including protected areas, activities within protected areas, control of hunting, import and export of wildlife, enforcement and administrative functions of wildlife authorities. The 1989 amendment specifically established the Kenya Wildlife Service (KWS) as the parastatal charged with implementation of the provisions of the Act.

The Act specifically provides for the protection and regulation of protected animals, game animals and game birds as defined in three schedules. The first schedule includes game animals mostly mammals, although the list also includes crocodile and ostrich. The second schedule lists game birds, and the third schedule lists protected animals, which comprise primarily mammals, although it also includes two species of marine turtles, while in 1981 it was amended to include several species of reptiles, amphibians and butterflies. Apart from the protection provided to plants within National Parks and National Reserves, plants receive no further protection under this Act outside the protected areas.

Specific provisions of the Act allow for the establishment of National Parks (Section 6), National Reserves (Section 18), and local sanctuaries (Section 19). The National Parks are managed by KWS. Strict regulations prohibit various activities within National Parks, unless they are subject to the written consent of the Minister or, in other cases, the Director of KWS. No such prohibitions are specified for National Reserves or for local sanctuaries.

7.12 POLICY FRAMEWORK

7.12.1 Vision 2030

Kenya Vision 2030 is the country's new development blueprint covering the period 2008 to 2030. It aims to transform Kenya into a newly industrializing, "middle-income country providing a high quality life to all its citizens by the year 2030".

The Vision 2030 is founded on economic, social and political pillars anchored on macroeconomic stability; continuity in governance reforms; enhanced equity and wealth creation opportunities for the poor; infrastructure; energy; science, technology and innovation (STI); land reform; human resources development; security as well as public sector reforms.

Vision 4 of the paper is adding value to products and services. Under this vision, the country envisions raising incomes in agriculture, livestock and fisheries. The strategy proposes processing and adding value to her products before they reach the market. This is to be accomplished through an innovative, commercially oriented and modern agriculture, livestock and fisheries sector.

These interventions are expected to generate an additional KSh.80-90 billion increase in GDP, mainly through better yields in key crops, increased smallholder specialization in the cash crop sector (2-3 crops per plot), utilization of a million hectares of currently uncultivated land, and new cultivation of up to 1.2 million hectares of newly-opened lands. Specific strategies are to transform key institutions in agriculture and livestock to promote household and private sector agricultural growth and increase productivity of crops and livestock.

The Vision recognizes that Kenya is a water scarce country. The economic and social developments anticipated by Vision 2030 will require more high quality water supplies than at present. The strategy therefore, proposes water conservation and starting of new

ways of harvesting and using rain and underground water. The goal of the vision for 2012 is to promote agricultural productivity and increase area under irrigation and drainage from 140,000 to 300,000 hectares.

Specific projects to achieve this vision include constructing multi-purpose dams with storage capacity of 2.4 billion m³ along rivers Nzoia and Nyando, and rehabilitate and expand the major irrigation schemes (Bura, Hola, Kano Plains, Nzoia, Pekera, Kerio Valley, Mwea, Taita Taveta, Ewaso Nyiro North and Ngurumani) among others. This project will therefore contribute to the overall achievement of the different sectors of the vision 2030.

7.12.2 Poverty Reduction Strategy Paper

The Poverty Reduction Strategy builds on the Interim Poverty Reduction Paper (IPRSP) for the period 2000-2003, which was launched in June 2000. The strategy outlined measures aimed at revamping economic growth and poverty reduction by focusing on facilitating sustained and rapid economic growth; improving governance and security; increasing the ability of the poor to raise their income levels; improving the quality of life of the poor; and improving equity and participation.

One of the sectors outlined in the PRSP is agriculture and rural development. The strategy recognizes the important role of agriculture in poverty alleviation in Kenya. Furthermore, agricultural growth can catalyze growth in other sectors, with an estimated growth multiplier of 1.64, compared to 1.23 in non-agriculture (GOK, 2000).

To alleviate poverty, the strategy requires the agriculture sub-sector to grow at about 4-6% per annum. For this to happen, the strategy proposes implementing sound land use, water and environmental policies, facilitating long term investments in farm improvement, protecting water catchment areas by developing forest plantations and to improve small scale irrigation investments undertaken in poverty stricken areas among others.

7.12.3 Irrigation Policy

The Irrigation policy seeks to stimulate and guide irrigation and drainage development through targeted technical support, intensified investment in the sector, improved research and extension services, and capacity building for both technical staff and farmer organizations to ensure development and sustainability of the sector.

Other important aspects of this policy include; effective co-ordination of the sector, institutional reforms, and the enactment of a comprehensive legal framework for irrigation, drainage and water storage development.

The policy Objectives are to;

- 1) Expand land under irrigation and drainage by 40,000 ha per year.
- 2) Increase water harvesting and storage for irrigation and contribute to achieving a national average of 60 m³ water storage per capita up from the current 5.3 m³.
- 3) Improve the overall performance and service delivery of the sector.

- 4) Mobilize resources and investments in irrigation and increase Government financial allocation to irrigation to at least 2% of the annual national budget.
- 5) Improve sector financing and investments by development partners, private sector and stakeholder contributions.
- 6) Create an enabling environment for the participation of farmers, irrigation water user groups and all stakeholders in the planning, implementation and management of irrigation.
- 7) Enhance business orientation and commercial farming in irrigated agriculture.
- 8) Build human resource capacity for irrigated agriculture.
- 9) Enhance the utilization of innovation, research, science and technology in irrigation.
- 10) Promote and adopt a multi-sectoral approach to sustainable irrigation development.
- 11) Promote, coordinate, manage and regulate activities of stakeholders within the sector.
- 12) Establish an appropriate, legal, institutional and regulatory framework for the sector.

7.12.4 Draft Wetland Policy

In recognition of wetlands importance and values, the threats facing them and the need to take concrete steps to safeguard their functionality for posterity, the Government of Kenya adopted the National Policy for the Conservation and Management of wetlands to ensure that they are sustainably managed and used wisely for the benefit of the present and future generations.

The policy objectives are to, establish an effective and efficient institutional and legal framework for integrated management and wise use of wetlands which will provide an enabling environment for the participation of all stakeholders, enhance and maintain functions and values derived from wetlands, protect biological diversity and improve essential processes and life-support systems of wetlands, promote communication, education and public awareness among stakeholders to enhance their participation in wetland conservation, carry out demand driven research and monitoring on wetlands to improve scientific information and knowledge base, enhance capacity building within relevant institutions and for personnel involved in conservation and management of wetlands, establish a national wetlands information management system and database including tools and packages to targeted groups, promote innovative planning and integrated management approaches towards wetlands conservation and management in Kenya and promote partnership and cooperation at regional and international levels for the management of transboundary wetlands and migratory species.

National Wetlands Conservation and Management Policy are guided by principles which include wise use of wetlands, precautionary principle: Where information is inadequate for decision making, the precautionary principle will apply. Lack of full scientific certainty should not prevent implementation of measures to minimise/manage wetland degradation, participatory approach and having global dimension of environmental impacts of actions and policies should be recognised and considered.

7.12.5 National Food Policy

The rapid expansion of the population and a shortage of arable land in the main high potential areas were beginning to expose a potentially dangerous imbalance in the

relationship between the national supply of and demand for food. In these circumstances, there was a clear need for a national policy which will set guidelines for decision- making on all major issues related to food production and distribution. The overall objective of this policy was to:

- Maintain a position of broad self-sufficiency in the main foodstuffs in order to enable the nation to be fed without using scarce foreign exchange on food imports;
- Achieve a calculated degree of security of food supply for each area of the country; and
- Ensure that these foodstuffs are distributed in such a manner that every member of the population has a nutritionally adequate diet. The project is in line with the National food policy.

7.13 INTERNATIONAL REGULATIONS

Kenya is a signatory to a number of conventions on sustainable development and is a member of various bilateral and multilateral organizations. Some of the relevant development partners in this project are the World Bank and a number of United Nations agencies.

7.13.1 World Bank Safeguard Policies

World Bank Operational Policies (OP) and Bank Procedures (BP) Environmental Assessment – BP 4.01 and OP 4.01 require environmental assessment of projects proposed that are deemed to have potential adverse impacts upon the environment to help ensure that they are environmentally sound and sustainable.

Environmental Assessment is one of the 10 environmental and social Safeguard Policies of the World Bank. World Bank Environment and Social Safeguard Policies aim at improving decision making, to ensure that project options under consideration are sound and sustainable, and that potentially affected people have been properly consulted.

The World Bank's environmental assessment policy and processes are described in Operational Policy (OP)/Bank Procedure (BP) 4.01.

In accordance with the Bank guidelines, the Lower Nzoia Irrigation Development Project has been classified as category B. The following safeguards are triggered: Environmental Assessment (OP 4.01), Pest Management (OP 4.09), Involuntary Resettlement (OP 4.12), and Projects on International Waterways (OP 7.50).

7.13.2 Environmental Assessment (OP 4.01)

This policy requires environmental assessment (EA) of projects proposed for Bank financing to help ensure that they are environmentally sound and sustainable, and thus to improve decision making. The EA is a process whose breadth, depth, and type of analysis depend on the nature, scale, and potential environmental impact of the proposed civil works under the MIS improved water management project. The EA process takes into account the natural environment (air, water, and land); human health

and safety; social aspects (involuntary resettlement, indigenous peoples, and cultural property) and trans-boundary and global environmental aspects.

Operational Policy 4.01 further requires that the ESMF which is a safeguard tool/document prepared when OP 4.01 is triggered must be disclosed as a separate and stand-alone document by the Government of Kenya and the World Bank as a condition for bank appraisal of this improved water management project. The disclosure should be both in Kenya where it can be accessed by the general public and local communities and at the Info shop of the World Bank and the date for disclosure must precede the date for appraisal of the program.

The World Bank system assigns a project to one of three project categories and the project has thus been screened and assigned an EA Category B. This category of projects are defined as projects likely to have potential adverse environmental impacts on human populations or environmentally important areas including wetlands, forests, grasslands, and other natural habitats and are less adverse than those of category A projects. These impacts are site specific, few if any of them are irreversible, and in most cases mitigation measures can be designed more readily than for Category A projects. The EA process for Category B projects examines the potential negative and positive environmental impacts and recommends any measures needed to prevent, minimize, mitigate, or compensate for adverse impacts and improve environmental performance.

7.13.3 Natural Habitats (OP 4.04)

This policy aims at the conservation of natural habitats, like other measures that protect and enhance the environment. The policy is essential for long term sustainable development. The Bank therefore supports the protection, maintenance, and rehabilitation of natural habitats.

Natural Habitats are land and water areas where the ecosystems' biological communities are formed largely by native plant and animal species, and human activity has not essentially modified the areas primary ecological functions. The policy recognizes the important role of biological, social, economic, and existence value of natural habitats. Natural habitat policy covers habitats in the tropical humid, dry, and cloud forest; temperate and boreal forest; Mediterranean-type shrub lands; natural arid and semi-arid lands, mangrove swamps, coastal marshes, and other wetlands; estuaries, sea grass beds, coral reefs, freshwater lakes and rivers; alpine and sub alpine environments, including herb fields, grasslands, tropical and temperate grasslands.

Therefore, the Natural Habitats policy is only triggered in certain cases because the investments proposed under may have potential adverse impacts on adjacent rivers, and forests which are located within the project catchment of some of the site and immensely contribute to the sustainability of critical ecosystems. The natural ecosystems of the wetlands, rivers and forests are known to support varying degrees of natural complexities of flora and fauna.

This OP requires that any activities that adversely impact these ecosystems are successfully mitigated so that the balance of the ecosystems are maintained or enhanced.

Though the project area lacks any natural habitat as the area has been cultivated before, the presences of Yala swamp bordering the project area might be affected by secondary impact from land owners who would form part of the out growers outside the project area. This would require NIB to design appropriate conservation and mitigation measures to remove or reduce adverse impacts on these ecosystems or their functions, keeping such impacts within socially defined limits of acceptable change. Specific measures may depend on the ecological characteristics of the affected ecosystem. Such measures must include provision for monitoring and evaluation to provide feedback on conservation outcomes and to provide guidance for developing or refining appropriate corrective actions.

As described in section 5.2, the proposed area for the project is already cultivated and only when it floods it's when it's left fallow. As such the policy will not be triggered in this case.

7.13.4 Forests (OP 4.36)

This operational policy aims to reduce deforestation, enhance the environmental contribution of forested areas, promote afforestation, reduce poverty, and encourage economic development. The policy recognizes the role forests play in poverty alleviation, economic development, and for providing local as well as global environmental services. Success in establishing sustainable forest conservation and management practices depends not only on changing the behaviour of all critical stakeholders, but also on a wide range of partnerships to accomplish what no country, government agency, donor, or interest group can do alone.

The forest strategy suggests three equally important and interdependent pillars to guide future Bank involvement with forests including harnessing the potential of forests to reduce poverty, integrating forests in sustainable economic development, and protecting vital local and global environmental services and forest values.

This policy applies to the World Bank-financed investment projects that have or may have impacts on the health and quality of forests, projects that affect the rights and welfare of people and their level of dependence upon or interaction with forests and projects that aim to bring about changes in the management, protection, or utilization of natural forests or plantations, whether they are publicly, privately, or communally owned. This safeguard will not be triggered as there are no forests within the project boundary that will be affected.

7.13.5 Pest Management (OP 4.09)

The policy supports safe, affective, and environmentally sound pest management. It promotes the use of biological and environmental control methods. An assessment is made of the capacity of the country's regulatory framework and institutions to promote and support safe, effective, and environmentally sound pest management. The project will trigger this policy enduring the operational phase of the irrigation.

Rural development and health sector projects have to avoid using harmful pesticides. A preferred solution is to use Integrated Pest Management (IPM) techniques and encourage their use in the whole of the sectors concerned.

This policy aims at assisting proponents to manage pests that affect either agriculture or public health. The Bank supports a strategy that promotes the use of biological or environmental control methods and reduces reliance on synthetic chemical pesticides.

In appraising a project that will involve pest management, the Bank assesses the capacity of the country's regulatory framework and institutions to promote and support safe, effective, and environmentally sound pest management. As necessary, the Bank and the proponent incorporate in the project components to strengthen such capacity.

For World Bank funded agriculture projects, pest populations are normally controlled through IPM approaches, such as biological control, cultural practices, and the development and use of crop varieties that are resistant or tolerant to the pest. The Bank may finance the purchase of pesticides when their use is justified under an IPM approach. The Nzoia project must therefore adopt IPM approaches and only use pesticides as a last resort.

The policy supports use of pesticides for public health projects in controlling pests where environmental methods alone are not effective. The policy calls for assessment of the nature and degree of associated risks, taking into account the proposed use and the intended users for procurement of any pesticide in Bank-financed projects.

The policy requires that any pesticides it finances be manufactured, packaged, labelled, handled, stored, disposed of, and applied according to standards acceptable to the Bank. The Bank does not finance formulated products that fall in WHO classes IA and IB, or formulations of products in Class II³, if the country lacks restrictions on their distribution and use; are likely to be used by, or be accessible to, lay personnel, farmers, or others without training, equipment, and facilities to handle, store, and apply these products properly. This policy will be triggered by the project due to application of pesticides and herbicides in the irrigated blocks. An Integrated Pest Management Framework (IPMF) accompanied by an Integrated Pest Management Plan (IPMP) has been prepared separately for this project to satisfy OP 4.09.

7.13.6 Physical Cultural Resources (OP 4.11)

The bank operational policy on safeguarding cultural properties aims at protecting cultural assets and knowledge of communities in bank financed project areas. Safeguarding cultural property policy requires the determination of what is known about the cultural aspects of the proposed project site. The policy calls for consultation involving all parties including scientific institutions and NGOs as part of this process.

³ Copies of the classification, which is updated annually, are available in the Sectoral Library. A draft Standard Bidding Document for Procurement of Pesticides is available from OPCPR.

The policy defines cultural property as sites having archaeological, paleontological, historical, religious and unique natural value. These sites, when stumbled upon, require that the authorities are informed and the site is demarcated and protected.

As identified in section 5.1.6, the area earmarked for development is individual farms that are cultivated occasionally when there are no floods and as such there is potential for physical cultural resources being found in the areas where the civil works of the project will be carried out.

7.13.7 Projects on International Waterways (OP 7.50)

This policy recognizes the importance of cooperation and good will of riparian's as essential for the efficient utilization and protection of international waterways and attaches great importance to riparian's making appropriate agreements or arrangements for the entire waterway or any part thereof. Projects that trigger this policy include hydroelectric, irrigation, flood control, navigation, drainage, water and sewerage, industrial, and similar projects that involve the use or potential pollution of international waterways.

This policy relates to the relations between the riparian states. In the absence of such agreements or arrangements, the Bank requires, as a general rule, that the prospective proponent notifies the other riparian of the project. The policy lays down detailed procedures for the notification requirement, including the role of the Bank in affecting the notification, period of reply and the procedures in case there is an objection by one of the riparian to the project.

The policy applies to any river, canal, lake, or similar body of water that forms a boundary between, or any river or body of surface water that flows through, two or more states, whether World Bank <http://wbln0018.worldbank.org/Institutional/Manuals/OpManual.nsf/58aa50b14b6bc071852565a30061beb6/14f8e95499c0ce2285256763006252c0?OpenDocument> members or not. It also includes any tributary or other body of surface water any bay, gulf, strait, or channel bounded by two or more states or, if within one state, recognized as a necessary channel of communication between the open sea and other states and any river flowing into such waters.

The policy recognizes prior riparian states agreements/arrangements such as the Nile Basin which the project falls under. The policy also calls for notification of riparian states by parties that proposes to undertake project that affects international waters.

This safeguard will be triggered as Nzoia River is within the Nile River basin that is shared by 8 riparian countries thus the need to notify other riparian countries. A notification to the riparian states is being prepared by GOK under the MWI - Transboundary Projects Department.

7.13.8 Involuntary Resettlement (OP 4.12)

This policy covers direct economic and social impacts that both result from Bank-assisted investment projects, and are caused by; involuntary taking of land resulting in

relocation or loss of shelter; loss of assets or access to assets, or loss of income sources or means of livelihood, whether or not the affected persons must move to another location; or the involuntary restriction of access to legally designated parks and protected areas resulting in adverse impacts on the livelihoods of the displaced persons. For project activities that impact people and livelihoods in this way, NIB will have to comply with the requirements of the disclosed RPF and this is why a RAP has also been prepared to comply with this policy. The policy is triggered in situations involving involuntary taking of land and involuntary restrictions of access to legally designated parks and protected areas. The policy aims to avoid involuntary resettlement to the extent feasible, or to minimize and mitigate its adverse social and economic impacts.

The objective of this policy is to avoid where feasible, or minimize the resettlement, exploring all viable alternative project designs. The policy calls for sustainable development programs, providing sufficient investment resources to enable the persons displaced by the project to share project benefits and to improve their livelihoods. The standards of living should be restored, in real terms, to pre-displacement levels or to levels prevailing prior to the beginning of project implementation, whichever is higher.

To address the impacts covered under this policy, a resettlement plan or a resettlement policy framework is needed to mitigate against effects of displacement. This framework should cover the development of a resettlement plan which must include measures to ensure that the displaced persons are informed about their options and rights pertaining to resettlement. The displaced persons are consulted on, offered choices among, and provided with technically and economically feasible resettlement alternatives and provided prompt and effective compensation at full replacement cost for losses of assets attributable directly to the project.

If the impacts include physical relocation, the resettlement plan or resettlement policy framework includes:

- Measures to ensure that the displaced persons are provided assistance (such as moving allowances) during relocation;
- Provided with residential housing, or housing sites, or, as required, agricultural sites for which a combination of productive potential, locational advantages, and other factors is at least equivalent to the advantages of the old site.

Where necessary to achieve the objectives of the policy, the resettlement plan or resettlement policy framework should also include measures to ensure that displaced persons are offered support after displacement, for a transition period, based on a reasonable estimate of the time likely to be needed to restore their livelihood and standards of living and provided with development assistance such as land preparation, credit facilities, training, or job opportunities, in addition to compensation measures.

The World Bank Safeguard policy OP 4.12 will be triggered because the project will cause land acquisition for the infrastructure only and not the farms.

7.13.9 Projects in Disputed Areas (OP 7.60)

This policy is triggered in circumstances where there are territorial disputes between countries. The proposed site for the proposed project is not under any dispute for Kenya's neighbouring countries hence it is not triggered. The policy calls for a no objection from the other claimant to the disputed area, or when the special circumstances of the case support Bank financing, notwithstanding the objection. The policy details those special circumstances. The project area is not under any dispute as far as this study is concerned. The project will be undertaken in private land whose title owners consent will be sorted.

7.13.10 Indigenous Peoples (OP 4.10)

This policy recognizes that Indigenous Peoples, as social groups with identities that are distinct from dominant groups in national societies, are often among the most marginalized and vulnerable segments of the population. The policy aims to protect the indigenous peoples as many a time economic, social and legal status often limits their capacity to defend their interests in, and rights to, lands and natural and cultural resources, and may restrict their ability to participate in and benefit from development. They are particularly vulnerable if their lands and resources are transformed, encroached upon by outsiders, or significantly degraded. Their languages, cultures, religions, spiritual beliefs, and institutions may also be under threat. These characteristics expose Indigenous Peoples to different types of risks and severity of impacts, including loss of identity, culture, and natural resource-based livelihoods, as well as exposure to impoverishment and disease.

The policy makes a connection between the identities and cultures of Indigenous Peoples and establishes the inextricable links to the lands on which they live and the natural resources on which they depend. These distinct circumstances expose Indigenous Peoples to different types of risks and levels of impacts from development projects, including loss of identity, culture, and customary livelihoods, as well as exposure to disease. Gender and intergenerational issues among indigenous peoples are also complex. As social groups with identities that are often distinct from dominant groups in their national societies, Indigenous Peoples are frequently among the most marginalized and vulnerable segments of the population. The policy recognizes that Indigenous Peoples play a vital role in sustainable development and that their rights are increasingly being addressed under both domestic and international law.

The policy stipulates that if a proponent proposes to locate the project on, or commercially develop natural resources located within, traditional or customary lands under use and adverse impacts can be expected on the livelihoods, or cultural, ceremonial, or spiritual use that defines the identity and community of the Indigenous Peoples, then the proponent must ensure that as part of the free, prior, and informed consultation process the affected communities are informed of (a) their rights to such resources under statutory and customary law; (b) the scope and nature of the proposed commercial development and the parties interested or involved in such development; and (c) the potential effects of such development on the Indigenous Peoples' livelihoods, environments, and use of such resources. Thus the Resettlement Action Plan and the Resettlement Policy Framework must take this into consideration and adequate public

consultation must be undertaken. There are no known or identified IP in the wider project area and thus this policy will not be triggered. A summary of the World Bank's environmental and social safeguard policies to be triggered by the project are as described in the **Table 22** below.

Table 22: Summary of the Operational Policies that will be triggered by the project

Operational Policy	Status	Comments
Natural Habitats	Not triggered	Not triggered as project area is already developed.
Environmental Assessment	Triggered	The project falls under partial EA, category 'B' projects
Forests	Not triggered	The project is not in a forested area
Pest Management	Triggered	Agricultural activities will involve the use of pesticides and fertilisers
Physical Cultural Resource	Triggered	The project is likely to encounter physical cultural resources
Involuntary Resettlement	Triggered	Several target areas for civil works and the project's infrastructure are in use and owned by several landowners thus there will be both economic and physical displacement
Indigenous peoples	Not triggered	The area does not have indigenous people
Safety of Dams	Triggered	The Nzoia Project entails the construction of a weir/dam
Projects on International Waterways	Triggered	R Nzoia part of the Greater Nile Basin
Projects in disputed areas	Not triggered	The project is not in a disputed territorial area by another country

7.14 INTERNATIONAL CONVENTIONS

Kenya is a signatory to some of the international conventions that are relevant to the ESIA its imperative that we review some of the conventions within which the study and the project is carried out.

7.14.1 United Nations Convention on Biological Diversity

The three goals of the United Nations Convention of Biological Diversity (UNCBD) are to promote the conservation of biodiversity, the sustainable use of its components, and the fair and equitable sharing of benefits arising out of the utilization of genetic resources. Kenya being a signatory of this convention it's supposed to work towards the achievement of the three goals. Agriculture based activities could have both adverse and beneficial impacts on crop genetic diversity.

The convention calls for the adoption of national strategies, plans and programmes for the conservation and sustainable use of biological diversity into their relevant sectoral and cross-sectional plans, programmes and policies. One of the tools that are prescribed for the management of biodiversity is environmental assessment. Article 14 of the convention deals with impact assessment and minimizing of adverse impacts of activities that are likely to cause significant adverse effects on biological diversity, (Glowka, L, *et al*, 1992).

7.14.2 Ramsar Convention on Wetlands

The Convention on Wetlands is an intergovernmental treaty which provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. There are presently 160 Contracting Parties to the Convention, with 1897 wetland sites. The Convention calls for governments to provide framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. However there are no Ramsar sites in the project area thus the convention does not apply.

7.14.3 Convention on the Conservation of Migratory Species

The convention on migratory species (CMS) was adopted to conserve migratory species of wild animals given that migratory species are seen as an international resource. Such species may be terrestrial or marine. The conventions agreement on the conservation of African-Eurasian migratory water birds is specific on the need to protect the feeding, breeding and wintering habitats, the main ones being wetlands and open water bodies. The convention is relevant due to presence of migratory bird species and other aquatic organisms.

7.14.4 EAC Protocol on Environment

The protocol was signed by the Partner States of the East African Community on 29th November 2003. It has relevant provisions for environmental and social management for the project; Article 5: Paragraph 4 provides that Partners States should promote sustainable utilization of water resources while taking into consideration factors such as ecology, geographic, climatic, hydrologic factors among others; the social and economic needs of each Partner State; the population dependent on the water resources; existing and potential uses of the water resources.

Article 6: Paragraph 1 identifies the protection and conservation of the basin and its ecosystem with emphasis on improving water quality and quantity; preventing the introduction of invasive species; conservation of biological diversity and forest resources; protection and conservation of wetlands and fisheries resources conservation. Part 2 of the article provides for the harmonization of laws and policies for stakeholder participation in protection, conservation and rehabilitation. Sustainable agriculture and land use practices to achieve food security and rational agricultural production is provided for in Article 9.

Article 12 of the Protocol urges Partner States to develop national laws and regulations requiring project proponents to undertake EIA and review of EIA reports to be done by all the Partner States if the potential impacts are likely to be trans-boundary and the same to apply for Environmental Audits in Article 13.

Partner states should ensure control of pollution from non-point sources through legal, economic and social measures. This is provided for in Article 20 which further states that pollution control measures should promote sustainable forestry practices, appropriate agricultural land use methods, sanitation and hygiene within the basin. Public participation is provided for in Article 22 which should be enhanced to influence government decisions on project formulation and implementation.

Article 23 of the Protocol provides that Partner States should promote Community involvement and mainstreaming gender concerns at all levels of socio-economic development especially in decision making, policy formulation and implementation of projects and programmes.

7.15 INSTITUTIONAL ARRANGEMENTS

The main institutions with responsibility for environment protection in the project are the: National Environment Management Authority (NEMA), Ministry of Environment and Mineral Resources (MEMR), Ministry of Water and Irrigation (MoWI), Ministry of Forestry and Wildlife (MoFW), Water Resources Management Authority (WRMA), Ministry of Lands and Ministry of Health among others. The overall institution is NEMA which has the power to control, monitoring and evaluation of the integration of environmental concerns in all development projects or activities in Kenya.

7.15.1 National Environment Management Authority

The National Environment Management Authority (NEMA) is established under Section 7 of the Act. NEMA is the institution with the legal authority to exercise general supervision and co-ordination over all matters relating to the environment, and is the principal instrument of the Government charged with the implementation of all policies relating to the environment. NEMA was established in 2001, and is headed by a Director General appointed by the President. The Director General is assisted by several directors in charge of Enforcement, Education, and Policy, who in turn are assisted by Assistant Directors and Senior Officers. To facilitate coordination of environmental matters at a District level, EMCA 1999 allows for the creation of District Environmental Committees (DEC) chaired by respective District Commissioners, and the appointment of a District Environmental Officer who oversees environmental coordination and is also secretary to the DEC.

7.15.2 National Irrigation Board

The NIB is a semi-autonomous body, established under the Irrigation Act of 1966, and is responsible for planning, construction, settling and managing national irrigation schemes. At present, NIB operates six schemes: Mwea (6,000 ha), Ahero (900 ha), West Kano (900 ha), Bunyala (300 ha), Perkerra (500 ha), and Hola (850 ha).

7.15.3 Ministry of Water and Irrigation

The Ministry of Water and Irrigation is the parent institution for this project. The NIB is under this Ministry. The Ministry of Water and Irrigation has its fundamental goal and purpose as conserving, managing and protecting water resources for socio-economic development. Its aim is to improve the living standards of people by ensuring proper access to available water resources. The fact that this ministry is only concerned with the development of irrigation infrastructure and management of water resources, the operation of the crop is the mandate of Ministry of Agriculture.

7.15.4 Ministry of Public Health and Sanitation

The Ministry of Public Health and Sanitation through the Public Health Division is involved in the provision of preventive health-care through mobilizing and sensitizing

of communities on water and sanitation matters through identification, planning and selecting appropriate. Technologies, water quality surveillance, water supply improvement at household and small group's levels, water quality monitoring and prosecution of offenders and environmental sanitation and hygiene promotion. The Ministry of Health lays emphasis on promotion of preventive health and hygiene and in this regard, management of water quality and adequate sanitation are given prominent consideration.

7.15.5 Ministry of Agriculture

The mandate of the Ministry of Agriculture is to promote and facilitate production of food and agricultural raw materials for food security and incomes; advance agro based industries and agricultural exports; and enhance sustainable use of land resources as a basis for agricultural enterprises.

Some of the relevant functions of the Ministry in regards to the project are formulation, implementation and monitoring of agricultural legislation's, regulations and policies, provision of agricultural extension services, supporting agricultural research and promoting delivery, development, implementation and coordination of programmes in the agriculture sector, regulating and quality control of inputs, produce and products from the agriculture sector, management and control of pests and diseases in crops and promoting management and conservation of the natural resource base for agriculture.

7.15.6 Water Resources Management Authority

The Water Resource Management Authority (WRMA) is a state corporation under the Ministry of Water and Irrigation established under the Water Act 2002 and charged with being the lead agency in water resources management. The duties of WRMA include;

- Water apportionment and allocation, catchment
- Catchment protection and conservation,
- Water resource assessments and conservation,
- Delineation of catchment areas,
- Gazetting water protected areas,
- Protection of wetlands,
- Gazetting water schemes to be state and community owned,
- Establishing Catchment Management Strategies (CMS)
- Collecting water use and effluent discharges.

The water Act provides for decentralized and stakeholder involvement. This will be implemented through regional offices of the Authority based on drainage basins (catchment areas) assisted by Catchment Area Advisory Committees (CAACs). At the grassroots level, stakeholder engagement will be through Water Resource User Associations (WRUAs).

7.15.7 Ministry of Livestock and Fisheries

Due to reduced grazing land for livestock in the project area, the Ministry of Livestock and Fisheries will be responsible for promoting improved breeds of cattle and zero grazing

7.15.8 Nile Basin Initiative

The Nile Basin Initiative (NBI) through is implementing basin wide Integrated Water Resources Management activities with the Lake Victoria Basin where the project falls. Activities of NIB could complement the activities of the project in the areas of planning and monitoring as well as economic development. According to the Nile Basin charter, the proponent need to inform other stakeholders of the Nile basin who depend on the waters of the Nile.

National Irrigation Board

Table 23: Institutional Capacity of ESMP Implementing Agencies

Institution	Focus	Strengths	Weakness	Recommendations
National Irrigation Board (NIB)	Irrigation	Operation of schemes such as Bunyala and pool of expertise in irrigation	Lack of functional project office at the at ground	Open a project office in the project area
National Environment Management Authority (NEMA)	Implementing environmental management	Political support Autonomous Strong legal foundation and institutional support	Inadequate manpower at the national and lack of control in the districts Inadequate enforcement of policies and legislation	Decentralise operations to the lower level of administration
Water Resources Management Authority	Water resources management.	Decentralised management system and focus on catchment as a system.	Lack of enforcement of rules and regulations such as water permits and lack of monitoring capacity	Need to monitor water resources abstracted from Nzoia River. Enforce water abstraction permit. Open district offices
Ministry of Agriculture	Facilitating production of food and agricultural raw materials for food security and incomes; advance agro based industries and agricultural exports; and enhance sustainable use of land resources as a basis for agricultural enterprises.	Presences of National Agricultural and Livestock Extension Program Supported by strong research arm (KARI)	Lack of resources for field work Inadequate local level extension workers Lack of pesticide policy Inadequate technical staff at the district level	Establish Integrated Pest Management program Transfer research knowledge to the farmers
Ministry of Public Health and Sanitation	Public Health and Sanitation services	<i>7.15.8.1.1.1 Presence of public health personnel at the divisional level. Implementing programme on indoor residual spraying and free</i>	Lack of resources for field work Lack of capacity and manpower to supervise public healthcare and sanitation projects	Promote preventive health care as opposed to curative i.e. eradication of mosquitoes as opposed to provision of TBN

National Irrigation Board

Institution	Focus	Strengths	Weakness	Recommendations
		<i>issuance of treated nets</i>		
Ministry of Livestock Development	7.15.8.1.1.2 <i>Sustainable and prosperous livestock and fisheries sub-sector.</i>	7.15.8.1.1.3 <i>Provision of support services that increase productivity, value addition and market access for the sub-sector products.</i>	Lack of capacity and manpower to supervise infrastructure projects.	Promote improved breeds and efficient grazing methods i.e. zero grazing in the project area
Ministry of Water and Irrigation	7.15.8.1.1.4 <i>To improve health by; enabling partnerships, provision of leadership information and education concerning the suppression of vectors, rodents and vermin, for accelerated development of methodologies that increase the effective and efficient utilization of vectors, rodents and vermin control services.</i> While irrigation is under the Ministry of water, extension	7.15.8.1.1.5 <i>Presences of autonomous WRMA to deal with water resources issues</i>	Lack of resources for field work. Lack of resources to monitor public health issues at the community level. Delinked from agriculture which is part of irrigation Lack of irrigation personnel in the ministry. Focus has been more on provision of drinking water	Ministry of Water and Irrigation and Agriculture should complement each other to promote irrigated agriculture

National Irrigation Board

Institution	Focus	Strengths	Weakness	Recommendations
	services are in the Ministry of Agriculture			

8 POTENTIAL ENVIRONMENTAL & SOCIAL IMPACTS & PROPOSED MITIGATION MEASURES

Irrigation projects are known to lead to a number of environmental benefits, interactions and consequences. As with most water development projects, general hydrological disturbance and the risk of diseases are there. This section of the report discusses the potential environmental and social impacts of the proposed project and is based on international experience of irrigation development projects. The impacts described are both beneficial and adverse occurring on physical, biological and socio-economic environment during construction and operational phase.

In undertaking this environmental impact identification for the proposed irrigation development potential sources of risk to the ecological and social environment were first identified. Each source of risk identified was described and its potential environmental impact considered.

8.1 BENEFICIAL IMPACTS

The Bunyala area has for a long time suffered from perennial flooding, crop loss, high poverty rates, poor infrastructure and poor health. Though fishing is a major source of livelihood, there has been hardly any other substantive source of livelihood for the region. Rice farming is only undertaken in small proportions where as a large area of the region is suitable for irrigated farming. The introduction of the Lower Nzoia Irrigation Project provides a strong platform for a number of positive effects to the region. These positive impacts are discussed in the following sections.

8.1.1 Physical Impacts

8.1.1.1 Water Resources Conservation

The project will invest in an infrastructure that will be used by local communities for food production. This will ensure that even storm water is harnessed and used for productive purposes. This will prevent soil erosion and protect the hydrological systems from sedimentation, flooding and contamination. This project positive impact will help make use of the idle floodplains in the area. There will be promotion of indigenous tree growing in the project area thereby improving biodiversity and water conservation.

8.1.1.2 Flood Control

The spread of water into the farms will control floods downstream by distributing excess water during heavy rains. Flood control effects of the project will free more land for farming as well as prevent destruction of food crops for those farmers who cultivate floodplains during the dry season. This indirect impact will help achieve food security especially for rain depended crops. This is an immediate impact that will be realized during wet season when floods occur.

8.1.2 Ecological Impacts

8.1.2.1 Environmental Protection

The project promotes intensification of agriculture as opposed to extension. This will protect marginal areas as more food will be produced in a smaller area. Sustainable

agricultural intensification is not only important to increased employment and income, but also is critical to protecting the environment. The project will reduce the pressure on farmers to push onto more fragile lands or to rely on labour intensive gathering activities off-farm. The project will thus intensify farm production through the use of improved inputs that raise productivity.

This is an indirect impact that will protect marginal areas and sensitive ecosystems from agricultural encroachment. The paddy fields can also provide havens for migrating wetland birds. However, increased use of fertilizers and pesticides on the fields may pose a threat to the birdlife.

8.1.2.2 Create Birdlife Habitat

The rice paddies and other irrigated crops will attract birdlife in the project area due to availability of food for the birds. This would improve on the general diversity of life in the area but may also threaten the birds should the farmers treat them as pests thus necessary measures should be taken to prevent an endangering of the birdlife through this.

8.1.3 Socio-Economic Impacts

The project will have a number of positive social and economic impacts in the area and beyond. It will act as a vital pillar for socio economic improvement in the region contributing to growth and livelihood improvement. Identified positive socio-economic impacts are described below.

8.1.3.1 Poverty Alleviation

The Lower Nzoia basin straddles the Siaya and Busia districts both of which have 60-70% of their population living below the poverty line. These figures are among the highest in the country. The two districts have a population of 784,000 out of which 509,000 are poor. The poverty gap, which is the difference between the existing economic status of the population and the poverty line, ranges between 20-30% for the two districts and therefore there the government targets to intervene through the project in a manner that will have a significant and immediate impact on poverty reduction on a sizeable portion of the population of the two districts.

Kenya Poverty Reduction Strategy Paper (PRSP, Kenya, 1999) identifies agricultural development as one of the key drivers of eradicating poverty in the country and ensuring food security. Based on the Kenya RRSP, the project is in line with the objective of tackling poverty through promotion of agriculture.

At the local level, the irrigation infrastructure project will promote increased agricultural productivity, diversification of agricultural crops and commercialization of agriculture from subsistence. Improvement in crop productivity will raise the income for the rural poor above the poverty line of less than a dollar a day. This is an indirect impact that will take a long process that will be felt after many years. Directly the project will benefit an estimated 20,000 people.

8.1.3.2 Food Security

Kenya is a food insecure country. In order to reverse this situation, more land need to be put into production and more so through irrigation. The project will play an important role on Kenya's food security situation especially in Nyanza where food insecurity is common occurrence. This project is in addition tailored to provide farmers with an option on the type of crops that they will plant within the scheme. It will therefore result in an increase in food supplies all year round thereby improving food security and nutrition levels. This will be an immediate and direct impact to the locality and neighbourhoods.

8.1.3.3 Rural Income Improvement

The overall objective of the Lower Nzoia Irrigation Project is to induce a commercially sustainable agriculture for improved income level for the household, and thus help in poverty alleviation, which is the core socioeconomic problem in the area. Poverty is to be alleviated through provision of irrigation water, which apart from creating the condition for more production and intensification will also reduce the high risk in agricultural production.

8.1.3.4 Market Creation

The project will create a market for farm inputs including seeds, fertilizers, pesticides and herbicides. This is a direct beneficial impact that would be felt during implementation and after the project is operational and crops are harvested from the fields.

8.1.3.5 National Economy

Agriculture remains the backbone of the Kenyan economy. It is the single most important sector in the economy, contributing approximately 25% of the GDP, and employing 75% of the national labour force (Republic of Kenya 2005). Over 80% of the Kenyan population live in the rural areas and derive their livelihoods, directly or indirectly from agriculture.

Implementation of the proposed Lower Nzoia Irrigation Scheme Phase 1 is expected to bring approximately 4,043 ha of land under irrigation and benefit more than 2,100 small scale farmers through improved production of food and provision of incomes. It is expected that an average household will gain approximately Kshs. 392,000 from irrigated farming annually. The increase of the irrigated area from the existing 705 hectares to 4043 hectares will be a major boost to the Kenyan economy whose target is to increase the area under irrigation by 40,000 hectares annually. In addition to irrigation infrastructure, the project will benefit from support in post harvest handling and marketing infrastructure and support for management investments which are covered under components 2, 3 and 4 respectively. The project's incremental benefits are expected to be more than Kshs 1.27 billion once production stabilizes. The project is however, expected to cost more than Kshs. 4.4 Billion. Financially, the project is found to be viable resulting to acceptable discount rates and positive cash flows that will guarantee its sustainability. Further, expected household incomes are enough for the

farmers to contribute towards operation and maintenance costs further guaranteeing sustainability of the project.

Economically, the project would result to positive externalities in the country as economic benefits are more than the economic costs of the project. Additionally, the provision of food to the country, creation of employment opportunities and generation of foreign exchange from tradable commodities will positively contribute towards the country's gross domestic product GDP and Balance of Payments (BOP). Compared to these benefits, the major negative externality relate to the potential pollution of the soil and water resources following use of agrochemicals and the alteration of natural flora and fauna as a result of farming activities. However, a sound social and environmental management plan has been developed against these negative externalities.

8.1.3.6 Rural Employment

Under the Kenya Economic Stimulus Programme, emphasis has been placed on applying human labour in projects in order to provide significant employment opportunities. This project is no different and will therefore provide substantive employment opportunities to local populations. It is anticipated that the project will provide direct employment to over 5,000 people over duration of two years during the construction phase including weir construction, levelling of the grounds and construction of drains and canals and another 300,000 during the operational stage. Indirect employment through aspects such as transportation, infrastructure maintenance, markets, research and marketing will be far much greater and over a longer period of time.

Rice growing is a labour intensive venture and for this reason the labour needed in the project areas will create much needed employment opportunity to the rural population. A hectare of rice paddy requires 34.5 man days labour force (Christine Padoch, 2005). Based on the total area under rice, 20% (700 ha.) earmarked for this project, a total of 24,150 man days job opportunities will be created by the project seasonally. Some of the areas that will absorb the labour force will be in the areas of seed bed preparation, weeding, fertilizer application and drying. This is a long term impact that will be realised during the operational phase of the project. The project will enable poor household's better access to the local and national economies.

8.1.3.7 Capacity Building

One of the projects objectives is to build capacity of the stakeholders in soil and water conservation methods, agronomy, IPM among other areas of rural economy. The IWUAs members will also benefit in terms of training in irrigation operation and maintenance. This project impact will have effect on rural life especially in agricultural sector.

8.1.3.8 Improvement of Infrastructure

This project will include improvement of existing infrastructure in the project area. It will entail grading of existing roads with murrum of up to 200mm. As a result of this

improvement communication and transportation especially of farm products will be improved enhancing incomes and productivity.

The project area currently has a road network that is usually impaired by weather conditions. There is an all-weather road (tarmac) from the Busia Road junction at Bumala which ends about 15km from the project area. Transportation of products both agricultural and fisheries are usually hampered by poor conditions of roads particularly during the rainy seasons and when flooding of the River Nzoia occurs.

Improvement of the road network will ensure that products from both sectors are easily accessible to markets. It will also reduce inconveniences to population movements to public utilities such as schools, government offices and hospitals.

8.1.3.9 Reduced Malaria Cases

Incidence of malaria is often correlated with presence of stagnant water. This undoubtedly is true and cultivating flooded areas may improve living conditions for the local people living near the floodplain. It is, however, interesting to note that contrary to popular belief, swamps in their natural conditions are not necessarily a potent source of human disease. For example Beadle (1960) found that the two most important malaria carriers in Africa (*Anopheles gambiae* and *A. funestus*) do not breed in the interior of swamps though they are often found in open pools, footprints and other small hollows around the edges. An important factor which prevents some mosquitoes and not others from breeding in swamps is the low concentration of oxygen in the peaty water. Larvae of *A. gambiae* have difficulty in surviving under anaerobic conditions.

8.2 POTENTIAL ADVERSE IMPACTS

8.2.1 Physical Environment

8.2.1.1 Water Wastage

The Design Consultant OO&P in his Final Design Report of April 2012 (Section 8.4.2, Page 88) used 85% for Conveyance Efficiency and 60% for On-farm Efficiency giving the overall efficiency of 51%.

Mitigation

For losses through ground seepage, the transfer canals should be lined. This will prevent ground seepage of water in loose soil. The irrigation farmers can adopt water saving irrigation approach. The basic feature of water-saving irrigation is that there is no water layer on the fields throughout 75%-85% of the rice growing season when the air temperature is lower than 18°C during the early stage of tillage. This impact could be mitigated through adoption of these Chinese rice irrigation system where the paddies are drained during the day time and flooded in the evening. This method of irrigation has proved to be efficient in water usage. Under water-saving irrigation systems saves water loss up to 67.1%. This strategy can only be adopted by careful consideration and research which can be undertaken by Kenya Agricultural Research Institute (KARI).

8.2.1.2 Changes in Hydrology

The abstraction of water from Nzoia River will have impact of the hydrological flow of the riverine system. The impact will affect the general hydrological flows including current existence on the shores of Nzoia River. This is an operational impact that will be permanent in nature. The River Nzoia would be the main source for irrigation. It has a total length of **334 km** and catchment area of **12,450 km²** comprising of distinct drainage areas originating from (i) Mt Elgon area (ii) Cheranganyi (iii) Bungoma Kimilili and South Nandi hills including Kakamega area and (iv) Lower Nzoia area upto Lake Victoria. Its long-term average annual discharge is **146m³/s**. The river has an average slope of **2%**. "The maximum gross irrigation requirements of the mixed cropping pattern at the distributary outlet is 0.45 l/s/ha from **Table 5**, the requirements per 4041 Ha NCA for Month of January is 1.83 m³/s. The figure has been adopted and has been increased by 15% to allow for a margin of safety, producing the final continuous design watering rate at the distributary outlet of 0.52 l/s/ha.

Because of social pressures and practical difficulties caused by night-time irrigation, only day-time watering is recommended. It is essential; however, that full use of the daylight is made so that scheduling can be organized correctly. Therefore a 12 hour irrigation day has been adopted. The actual design watering rate at a distributary outlet during the irrigation day is therefore 1.04 l/s/ha".

However, the recently hired local agronomist and agricultural economist have updated the cropping pattern and accordingly water requirements for the selected crops and the revised cropping pattern were worked out by the irrigation team as shown in the following **Table 5** which also shows the water balance and environmental flows and water availability after meeting the requirements of Phase I &II as well as the environmental flows. The highest irrigation water requirements is in July and it amounts to 4.03m³/s and 2.1m³/s for phase I and II respectively, while the environmental flows (0.3 f Q₉₅) amounts to 8.21m³/s which leaves 43.72 m³/s as surplus in the river in that month.

8.2.1.3 Environmental flows Assurance

Kenyan regulations require that 30% of Q₉₅ of the base flow (lowest mean semi-monthly flow) be retained as environmental flow requirement. This requirement has been calculated and deducted before the calculations of water availability discussed above. NIB states that upstream and downstream demands have been factored in to water availability calculations because there is plenty of water going downstream to Lake Victoria in most of the year after meeting the environmental requirements and the irrigation water requirements. To reduce the impact of the projects on the basin hydrology, the irrigation design should not divert more that 30% of the water flowing in the river.

River Flows

The river average reliable monthly flows are estimated as follows: The mean monthly flows are presented in **Table 24** and indicate that the monthly flow varies between 45.8m³/s in February (lowest) to 186.4m³/s in August (highest). The flows are over

100m³/s from April to November and then drop progressively to the lowest flow in February / March just before the onset of the rains.

Table 24: Monthly River Flows (RGS 1EF01 at Ruambwa)

Month	Mean monthly Flow (m ³ /s)
January	68.4
February	45.8
March	47.4
April	100
May	172
June	139
July	148
August	186.4
September	165.8
October	135
November	126.4
December	93.1

Source: Final Design Report by Design Consultant (December 2011)

Low Flows

Low flow analysis data has been presented in the Final Design Report for exceedance probabilities of 80 and 90% (Q80 and Q95). The Q80 flow is normally considered as the reliable flow for irrigation purposes and low flows analysis results presented by the Design Consultant show that the Q80 flows vary between 10.98m³/s in March – 70.29m³/s in August as shown in Table 25. However, a Q95 scenario was selected hence all the Q95 will be allowed to go as an environmental flow.

Table 25: Available flows (Q80 and Q95) at RGS 1EF01 at Ruambwa

Month	Q80 flow (m ³ /s)	Q95 flow (m ³ /s)
January	20.82	15.86
February	14.57	6.87
March	10.98	1.31
April	14.21	8.28
May	36.00	11.18
June	58.05	24.39
July	58.27	27.38
August	70.29	42.89
September	60.02	38.91
October	43.34	31.60
November	41.81	23.48
December	27.90	17.76

Source: Final Design Report by Design Consultant (December 2011)

8.2.1.4 Soil Erosion

During the preparation of the land for irrigation, clearance of vegetation from the area will expose the soils to agents of erosion, mostly water. This impact will occur during project construction and operational phase. The magnitude of this impact will include reduction in soil productivity and siltation of shores of Lake Victoria downstream. This impact will be long term and will manifest after a long period. Soil erosion could occur during the construction phase when loose soil is swept by waters and during the operational phase during irrigation and field preparation.

Mitigation

Soil erosion can be avoided during the construction and operational phase of the projects. To avoid soil erosion a number of measures are proposed. These are;

5. Avoiding vegetation clearance that will expose soil to agents of erosion during construction phase.
6. Revegetating the cleared sites with local species of vegetation
7. only clear areas earmarked for construction and
8. Mitigation of soil erosion during cultivation will be through terracing of the sloppy areas of the land and plating of Napier grass along the canals.

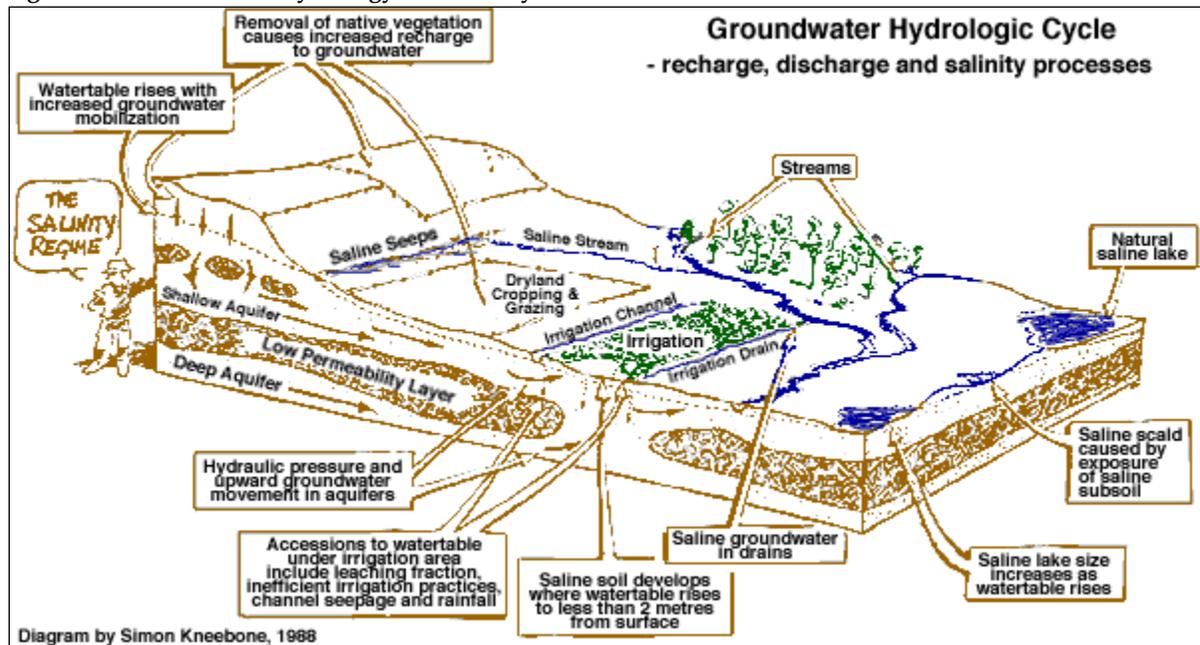
8.2.1.5 Waterlogging and salinization

As described on section 5.1.5 the area soil consist of somewhat excessively drained to poorly drained, deep to very deep, dark reddish brown to dark brown, mottled, loose to very firm, stratified sand to clay. On the southern parts of the project area (shown on figure 6 as SA1, SA2, SA3, SAC2 and SAC2) are slightly saline and slightly sodic and they are formed of cracking clay.

In the places where the soils are saline and poorly drained as is the case in the southern part of the project area, salinization could occur during the operational phase of the project. There are four main ways through which salinization can occur in irrigation project. These ways are:

1. Salts carried in the irrigation water are liable to build up in the soil profile, as water is removed by plants and the atmosphere at a much faster rate than salts. The salt concentration of incoming flows may increase in time with development activities upstream and if rising demand leads to drain water reuse;
2. Solutes applied to the soil in the form of artificial and natural fertilizers as well as some pesticides will not all be utilized by the crop;
3. Salts which occur naturally in soil may move into solution or may already be in solution in the form of saline groundwater. This problem often occur in deserts or arid areas where natural flushing of salts (leaching) does not occur and where the groundwater level is both high and saline, water will rise by capillary action and then evaporate, leaving salts on the surface and in the upper layers of the soil; and
4. The transfer from rain fed to irrigation of a single crop, or the transfer from single to double irrigation may create a "humidity/salinity bridge" in the soil, between a deep saline groundwater and the (so far) salt-free surface layers of the soil. Careful soil monitoring is highly recommended whenever the irrigated regime is intensified, even though the saline layers might be far below the soil surface and the irrigation water applied is of high quality.

Figure 30: Groundwater Hydrology and Salinity Process



The larger component areas of this project consist of low lying lands. This means that incidence of irrigation salivation in the project area will be high as there will be a lot of water logging. Irrigation salinity is the accumulation of salts in the topsoil under irrigation. It is caused by over-irrigation of agricultural land, inefficient water use, poor drainage and the irrigation of unsuitable and 'leaky' soils.

All of the above increase groundwater recharge and result in water table rise, bringing salts to the soil surface. The problem is exacerbated by the use of low quality (i.e. salty) irrigation water. Even mildly saline water can cause salinity problems because evaporation and plant uptake remove the water, leaving the salt to accumulate in the soil. Such scenario would result in the following.

- decreasing agricultural productivity
- damage to farm and urban infrastructure, including irrigation equipment
- declining groundwater and surface water quality

Mitigation

Alternative mitigation measures for this impact will be to use of salt-tolerant crops and managing the soils in the saline area identified.

The salts should be leached by applying more water that the plant requires to below the root zone and use of the designed drainages which will move the salts away from the root zone to locations in the soil, other than below the root zone, where they are not harmful. Irrigation salinity is a water balance problem and will be managed by reducing groundwater recharge by:

- avoiding over-irrigation by using irrigation techniques such as drip irrigation, monitoring soil moisture to determine when the soil needs irrigating and matching water applications to plant water requirements
- using deep-rooted crops and pastures to minimise deep drainage
- grow salt-tolerant species on salt-affected land
- Engineering solutions such as subsurface drainage to intercept deep drainage, surface drainage to collect surface runoff or groundwater pumping.

This impact will be minimised by construction of adequate drainage system in the farm. Some of the crops proposed that have higher tolerance to salts are beans, sorghum, carrot, onion and lettuce among others based on their tolerance to electrical conductivity.

8.2.1.6 Surface Water Resource Pollution

Water quality could deteriorate significantly due to reduced water recharge and balance leading to stagnation contributed by upstream use of fertilizers. Though not evident at this stage, agrochemical pollution could become a major problem with intensification of monoculture.

Lake Victoria is currently facing pollution problems that have contributed to eutrophication and reduced fish populations. The development of this project could contribute to high nutrient loads especially at the mouth of River Nzoia. This would in turn spur the growth of water weeds such as the hyacinth thereby destroying fish breeding grounds, reducing water oxygen levels and denying fishermen access to the lake.

Water pollution in the developed project area will occur through application of fertilizer and pesticides. The common chemicals to be applied will include nitrates, and phosphates compounds for fertilizers and dithane, Sumicombi, *Sumithion* and *karate* and *ridomil Dithane* for pesticides. Nitrates are highly soluble and therefore may quickly reach water bodies. Phosphates tend to be fixed to soil particles and therefore reach water courses when soil is eroded while phosphate saturated soils. This impact is compounded by the fact that nitrogen and phosphorous have low absorption rates of 30 and 15% respectively. There are high chances of nutrients leaching into water resources. These chemicals if applied in large amounts and at inappropriate periods will pollute water resources of the area and have cumulative effects in the basin and groundwater.

Pesticides applied will bio accumulate in the soaked soils of the lowlands upset the natural ecological balance and biodiversity of the wetlands downstream. Dithane is slightly toxic to birdlife and moderately to aquatic organisms. Therefore the use of dithane in the farms will have adverse effects on Lake Victoria wetlands. Fenitrothion is an insecticide belonging to the class of organophosphates. It is marketed and better known under the names of *Sumithion* and *Sumicombi*. The product is used to fight against pests, locusts and grasshoppers. The substance is highly toxic to aquatic organisms and might be hazardous to the environment. A particular attention must be given to shellfish and bees. Fenitrothion builds up in the food chain of humans, mainly

in fish. This product is strictly banned in aquatic environments. In USA, this product is specially authorized for specific purposes. As far as toxicity is concerned, the “acceptable” daily level for man is on the order of 0,005mg/kg. This insecticide has potential for aquatic contamination through seepage (El Hadji Hamath and Papa Maïssa, 2006). However based on the average pesticide use of 0.1 kg per ha of cropland, the magnitude of the impact is not going to be high.

Most of the crops proposed for the irrigation farming in the earmarked project area are more profitable when using fertilizer thus the strategic plan may promote intensive use of fertilizer. Nutrient enrichment in water bodies will increase biological activity and these could lead to eutrophication of the area and Lake Victoria. However inorganic fertilizer rarely causes environmental problems but poor agronomic practices could result in pollution of the water body⁴.

Water pollution through application of agrochemicals in the farms is an indirect and long term impact due to the nature of leaching of soils.

Mitigation

This impact can be reversible if IPM approaches are undertaken or farmers are trained in techniques of agrochemical applications. A training program should be developed for farmers on precautionary measures required for the handling, labelling and application of agro-chemicals under field conditions. The training should be incorporated in a farmer’s field school curriculum. Extension workers should also be able to deliver awareness program on the amounts and conditions for applying fertilizers and pesticides to prevent water pollution. Application of fertilizer during rainy season for example will lead to leaching. The same applies for pesticides and herbicides. Agrochemical application should only be done when it’s not rainy to allow the chemicals to soak and not leach.

Alternatively the project should adopt a more environmental sustainable approach of promoting Integrated Pest Management in the project. The alternative pest management methods should include a best mix of biological or cultural controls.

Alternatively mitigation against surface water bodies’ pollution especially into Lake Victoria and River Nzoia, the drainages from the irrigation command area should be through the design and establishment of an engineered buffer zone between the project area and the area Yala Swamp.

Hence for the right bank drainage, buffer zones (conservation areas) should be created downstream of the project area. These buffer zones will filter pollutant loads from

⁴ Free Ammonia (NH₃): Less than 0.2 mg/l: The lethal concentration for a variety of fish species is in the range 0.2 to 2.0 mg/l NH₃. Nitrates (N): Less than 10 mg/l: Nitrates cause eutrophication of fresh waters
Phosphates (P): Phosphates enrich fresh water environment with plant nutrients resulting in rapid algae growth which affect municipal, industrial and recreational uses.

upstream and those leaching from irrigated farms. This mitigation measure is in line with the Kenya National Wetland Policy section 2.1.3 on Water Purification, Nutrient and Toxic retention.

8.2.1.7 Sub-surface Water Contamination

Infiltration of irrigation water in excess of available root zone storage will penetrate beyond the reach of roots and eventually recharge groundwater. Nitrates, salts, and other chemicals used in crop cultivation that dissolve in the soil water will move with the water. Crops with high water and N requirements (rice and vegetables) will increase the potential risk of nitrate pollution to groundwater. Because they do not evaporate, nitrates/nitrites are likely to remain in water until consumed by plants or other organisms. This impact will be felt more in areas with light-textured soils and intensive production of shallow-rooted crops that will contribute to considerable nitrate losses by leaching. This will be an external cost of the project on the population.

Mitigation

Mitigating against ground water contamination will require similar measures as used in preventing surface water pollution. Preventive measures will include practicing IPM and rational application of fertilizer only as a last resort while use of organic manure to be encouraged.

8.2.1.8 Reduced Water Flow

Off-take of water for irrigation will result in reduced stream flows especially during the dry season. Rice will typically require anything between 1000mm and 3000mm of water per hectare per season depending on management efficiency including field losses. For a project of 3,500 Ha therefore, water requirements per season will range between 3,500,000mm and 105,000,000mm. These are the amounts of water that will be abstracted from R. Nzoia to undertake growing of rice.

Table 5 shows the water balance and environmental flows and water availability after meeting the requirements of Phase I & II as well as the environmental flows. The highest irrigation water requirements is in July and it amounts to 4.03m³/s and 2.1m³/s for phase I and II respectively, while the environmental flows (0.3 f Q₉₅) amounts to 8.21m³/s which leaves 43.72 m³/s as surplus in the river in that month. To maintain healthy environmental flow of Nzoia River, the above flow requirements will be stringently followed and observed.

Mitigation

There is a need to install master meters as part of the infrastructure to be developed. The master meter will be used to control the amounts of water abstracted from the rivers thus allowing for management of water flow downstream. Introduction of water abstraction fee for the project beneficiaries will also discourage wastage and conserve water use. This measure should be considered by NIB and WRMA.

8.2.1.9 Flooding

Constructed irrigation drainage and networks will increase the flow of water in the lowlands. This effect compounded by reduced vegetation will reduce holding capacities

of the area, thus increasing flooding potential downstream. This is cumulative impact as the area experiences flooding occasionally. The construction of the weir will flood a water surface area of 379789m² upstream of the weir. During the high flows of Nzoia River in the months of May to September, floods will occur upstream of the Weir and might submerge arable land on the banks of the River.

Mitigation

Most of the rivers and streams within the Nile River Basin catchment are prone to flooding. Flooding can only be controlled through reforestation of catchments, protection of river banks, and manmade structures such as dykes that will reduce the flow of water. There will also be need to strengthen already existing dykes along River Nzoia so as to minimize chances of the river breaking banks and spilling water into the project zone.

This is a cumulative impact as the Nzoia basin normally flood during the rainy season. The component on catchment and hillside management should promote catchment management especially upstream to control the intensity of the floods. The river banks of the channels leading the irrigated area should be protected to prevent water breaking the banks and flooding the fields. Flooding of the surface area of 379789m² upstream should only be along the river course to avoid land inundation upstream. To avoid this, the weir should have overflow spillway.

8.2.1.10 Microclimate Modification

Loss of vegetation cover in those areas to be irrigated will lead to modification of the microclimate in the project area. The vegetation of papyrus and typha, for instance, favours water retention and regulates the temperature, thus creating a micro-climate favourable to the formation of organic soils. Therefore the loss of this vegetation will lead to loss of organic soils in the project areas. This impact is cumulative in nature as the project areas are already under agriculture with activities not directly related to activities of this project.

Mitigation

This impact is unavoidable and therefore a compensation strategy that enhances similar habitat is proposed. The parts of the project area downstream that will be remain after development of the irrigation infrastructure should be protected and conserved to provide the services. Also to recover the services of the microclimate, planting of trees should be undertaken to create that ambient climate similar to what was in existence before.

8.2.1.11 Topsoil Stock Piles

During the construction phase, excavation earth from the weir in addition canals and drainages will create a pile up of soil. These activities may result in the increased erosion in areas where vegetation has been stripped and stockpiled. This could lead to increased suspended solids being deposited into the streams, Nzoia River and Lake Victoria at the mouth of the river.

Mitigation

Stock piles should be adequately secured through installation of soil traps until they can be moved elsewhere for reuse. Where possible, such soil stockpiles should be used to rehabilitate stripped and excavated zones so as to reduce incidences of stagnant water and pools which would be a safety risk for people as well as breeding grounds for mosquito.

8.2.1.12 Land Use Change

The project will change land use from grassland and farming land to irrigated farmland. A total of 3,500 Ha will be converted from present use to irrigated farmlands. This is a permanent impact that will reduce the area under conventional agriculture and/or grazing land use. Present land use can revert back to its status after decommissioning of the project but it will take a long period of time before the rejuvenation of the current habitat/vegetation.

Mitigation

This impact is unavoidable and can only be compensated through allocating those who will be displaced from their farms and conservation of natural habitats downstream. To enable sustainable land use in the project areas, an integrated land use plan should be developed within the catchments based on the three tier approach that considers wider Nzoia catchment, middle grounds and the lower areas (project area). This impact will be well understood and mitigated during the development of the Resettlement Action Plan.

8.2.1.13 Greenhouse Gas Emission

Greenhouse gas (methane) will be emitted from the rice paddies through methanogenesis process. The cumulative effects of greenhouse gas effect on the climate results in global warming. This is a cumulative impact as the paddies will emit GHGs during anaerobic decomposition of organic matter in the paddies. Though some of the methane produced will be oxidized by methanotrophs in the shallow overlying water, the vast majority will be released into the atmosphere. It should be noted that methane emissions from the paddies will be affected by rice varieties, water level, fertilizer application and crop phenology. This is unavoidable impact that cannot be eliminated. Rice paddies account for 15–20% of the world's total anthropogenic CH₄ emission (Neue and Sass, 1998). This impact will be confined in the areas under rice cultivation. At this point this study assumes that the entire 3,500 Ha will be under rice farming. This is an already existing impact as there are areas that cultivate rice such as the Bunyala Irrigation Scheme and Sisenye. Methane emission from rice paddies is a worldwide phenomenon that has global effects on climate change and the impact is not localised. Of the wide variety of sources, wetland rice fields are considered to be an important source of atmospheric CH₄.

Mitigation

Addition of compounds such as ammonium sulphate, which favour activity of other microbial groups over that of the methanogens, will reduce emission of methane from the paddies. However this measure has its own environmental impacts. Alternatively there are many rice varieties can be grown under much drier conditions than those

traditionally employed, with big reductions on methane emission without any loss in yield. Additionally, there is the great potential for improved varieties of rice to provide a much larger crop per area of rice paddy and so allow for a cut in the area of rice paddies, without a cut in rice production. This measure is not very conducive for Nzoia Irrigation project and so would not be ideal. Consideration of new ecological and efficient rice cultivation approaches that reduces GHG emissions should be considered for the project. These approaches include:-

Mitigating GHG from rice cultivation through:-

- Water management
- Mid-season drainage
- SRI (system of rice intensification)
- AWDI (Alternate wet/dry irrigation in rice cultivation)
- Inhibitor use
- Ammonium sulfate
- Iron supplement
- Phosphogypsum
- New cultivars
- Direct seeding replaces transplanting
- Nutrient management
- Site-Specific Nutrient Management (SSNM)
- Soil carbon stock
- Rotation cultivation

Management of CO₂

- Increasing C input by organic amendment, such as manure, compost, and plant residues
- No tillage or minimum tillage
- Rotation including cover crops

Management of CH₄

- Altering water management with mid-season aeration
- Improving organic matter management, such as composting and promoting aerobic decomposition of crop residues

Management of N₂O

- Improving N fertilizer application to match with crop demand
- Appropriate management of animal wastes and manure
- Introducing advanced fertilizers, such as slow-or controlled release fertilizers and
- Inhibitors

8.2.1.14 Siltation of Water Bodies

The source of water for this project is the River Nzoia. It feeds into the Lake Victoria and in extension the Nile Basin hydrology. Already, siltation is of major concern among all major rivers feeding into the Lake Victoria. The main source of such siltation has been catchment activities that have resulted in poor soil management, deforestation and apparent soil loss. So far, siltation is one of the major factors blamed for bank bursting

and flooding along River Nzoia. Irrigation on the lower Nzoia will contribute to siltation of the river mouth into Lake Victoria increasing the problem of flooding.

Mitigation

To prevent siltation of the River Nzoia, a catchment rehabilitation process should be up scaled to protect the soil from water runoff. This measure should be supported by creating buffer zones downstream of the area to trap the silt. Wider consultations and engagements should be sought by NIB to improve catchment management in the entire basin.

8.2.1.15 Climate Change Impacts-Extreme Drought

Climate change effects especially extreme droughts may compromise the ability of the River Nzoia to function as a system including social support services like irrigation and water supply. During extreme drought the availability of water for ensuring environmental flows and supporting the irrigation scheme may be a problem and a cause of concern.

Mitigation

As discussed in the environmental flow section, in times of low flows as a result of drought, the maintenance of the Rivers ecological balance remains paramount and as such restrictions on water usage especially for irrigation will be imposed i.e. irrigation will be halted an issue that may cause tension with the local communities who are beneficiaries and for that matter rigorous awareness creation will be required.

8.2.2 Biological Environment

8.2.2.1 Water Weeds

Though some areas of the project area are already seasonal and perennial flood plains experiencing the growth of water weeds, the existence of this project could lead to an increase in water weeds especially in the paddies and waterways. This could lead to reduced water flows and provide suitable breeding grounds for vectors such as mosquitoes hence exacerbating health problems such as malaria and bilharzias incidences. It will also result in the reduced efficiency of the system consuming more water than planned.

Mitigation

Proper maintenance procedures especially within the canals and blocks/paddy should be undertaken regularly to ensure that occurrence of water weeds is kept to a minimal.

8.2.2.2 Marginal Areas Encroachment

The project borders the vast Yala swamp to the south. The proximity of the project close to this important ecosystem could lead to indirect impact through encroachment of the swamp by communities' members who are not going to benefit from the project. The issue of out growers might be outside the scope of the project but increased benefits from the project might trigger interest in expanding to such marginal and sensitive environments including the Yala swamp.

Mitigation

To prevent encroachment of the Yala swamp, a buffer zone should be created around the southern part of the project boundary. The management of the project should also control unplanned outgrowers that might develop when the project is in operation.

8.2.2.3 Bird Poisoning

Bird poisoning through application of pesticides in the farms might occur as an indirect impact of the project. The wider project area has a rich birdlife and indiscriminate use of agrochemicals might have adverse impacts on the birdlife. However, this project does not anticipate use of aerial spraying which is more dangerous to bird life than localised application. The impact will be cumulative in nature as the region has other irrigation activities that use aerial spraying in the rice paddies grown.

Chemical Carbofuran – or Furadan – is designed to control insect pests in a wide variety of field crops such as potatoes, corn and soybeans. However, Carbofuran is also toxic to vertebrates, and has one of the highest acute toxicities to humans of any insecticide widely used on field crops. Furadan is widely used in Bunyala Irrigation Scheme (Birdlife, 2009).

Mitigation

To mitigate against birdlife poisoning, we propose that the farming technology to be adopted during the operational phase of the project should be environmentally friendly.

- IPM technology should be applied in pest management instead of inorganic agrochemicals.
- No aerial spraying should be undertaken
- The following list of pesticides should not be used in pest management

8.2.2.4 Fisheries Impacts

The project's irrigation and other structures (the diversion weir and the cross-drainage siphons on main canals, and culverts) have a high potential to reduce or prevent fish movement upstream. This will damage the breeding success of scientifically and economically important, globally threatened fishes unique to Nzoia River. The loss of habitat caused by channelization of the main rivers will affect the lake fishery to some degree, specifically by reduced recruitment of catfish and Tilapia if migration to spawning sites is affected. Additional negative impacts on fish could occur as a result of (i) changed hydrology of the wetlands, (ii) reduced flooded area, and (iii) pesticide runoff in drainage waters.

8.2.3 Social Environment

8.2.3.1 Resource Use Conflict

Livelihood in the project area is mainly centred on subsistence agriculture and livestock keeping. Conversion of land into predominantly irrigated land will reduce available pasture grounds for families keeping livestock as shown on section 5.3.4.2. Livestock keeping particularly in the lower areas of Budalangí is traditional in nature and animals are left to wander freely especially in the areas that flood and along Nzoia River. This may be partly attributed to the perennial flooding that occurs rendering a large portion of available land unsuitable for settlement and permanent use e.g. through agriculture.

When this project is implemented, most of this land will be taken up for irrigation and there will therefore be reduced opportunity for livestock keeping due to reduced availability of pastureland. This could lead to conflict between irrigating farmers and those keeping livestock.

There is probability of domestic animals ruining canals. This is already evident along the dykes of River Nzoia. Animals cause erosion at crossing points while accessing water and green pasture during dry periods. As a result, most of these points become problematic during heavy rains upstream as they form the bank breakage points thereby resulting in flooding.

Where poor agricultural methods particularly in soil and water quality management are evident, this will gradually cause a reduction of fish at the mouth of the River Nzoia due to resultant impacts discussed above. In this case this could result in conflicts between fishermen and the irrigating communities. Fishing is a major source of livelihood especially in the lower Nzoia basin and this could lead to major conflicts.

Contamination of water for domestic use by agricultural use provides potential for conflict. Water use is mainly centred on River Nzoia and shallow wells. Saturation of chemical from agricultural activities could cause changes in sub-surface and ground water qualities thereby affecting population health around the project area. This is a possible impact for as long as the project is operational. Possible conflicts among water users, for instance between household use and irrigation is likely. Women are the ones who mainly tend the household plots or use water for household chores

As noted above, women have different needs and use of water including for domestic household use, small households plots for agriculture, for animals among other things. Construction of irrigation schemes as well as dams, may limit women access to water for such needs. As a result, different needs of women with respect to land and water use should be taken into consideration when designing the Nzoia project to avoid their potential discrimination from access to land and water.

Further the project may ignore the role of women in agriculture and existing producer groups as well as water users associations. Similarly inadequate capacity, access to services (extension and others) and decision making especially for women may tilt the scale and cause further disparity among women who may be affected negatively by the investments.

Mitigation

To prevent conflict between irrigation farming and livestock keeping, extension services on improved livestock keeping that is more intensive than extensive should be promoted. Practises such as keeping fewer but better breeds that are of more economic benefit should be promoted. In addition, practices such as zero grazing should be introduced to reduce land requirement for livestock keeping.

Restricted and organized livestock keeping though paddocking and zero grazing will in effect reduce damages to the canal infrastructure. The project should also ensure

adequate focus of provision of water sources for domestic animals to reduce movements especially across and along the irrigation infrastructure. This can be centred on irrigation blocks so as to ensure that each block is self sufficient and adequately organized to minimize livestock movement.

Proper farm management should be instilled among the project's farmers so as to reduce incidences of poor soil management and contamination of water sources for domestic use. Extension services to train farmers on appropriate soil, water and farm chemical management should be engendered into the project to facilitate for proper soil and water management. This will in extension safeguard fish breeding zones and therefore reduce conflicts with the fishing communities. The project design should incorporate fallow areas where grazing should be undertaken within the project area.

The formation of Irrigation Water Users Associations or producers associations must be compelled to include gender inclusivity and this has been embraced by the Water Act for example and will be considered during the investment stages of the project in regard to institutional and organisation development framework.

8.2.3.2 Water-Borne Diseases

Water retained in the field and, canals will create a breeding environment for mosquitoes and snails. This situation will lead to increase in malaria cases and bilharzias. This is a cumulative impact as the area has high reported cases of malaria. Bilharzia is also a common problem in the area. In 2003 for example, out of Budalangi's population of 53,000 nearly 25,000 were displaced by floods. Some 10,000 people were accommodated in the District officer's camp, necessitating health emergency measures to control possible outbreaks of malaria, bilharzias, cholera and other water borne diseases (Daily Nation, 24th September 2003).

The snail (*Biomphalaria sudanica*), which can carry *Schistosoma mansoni*, plays a major role in wetlands. These snails have no difficulty in surviving under anaerobic conditions. They do not move very quickly nor spread far and the foci of infection are generally confined to small areas of water which people converge for washing and collecting water, or for fishing. The development in these areas may result in the snails spreading over large areas and the impact of irrigation on a variety of other diseases should be carefully assessed prior to reclamation.

Therefore, there is a possibility of these diseases spreading due to the project activities and operations and climate change. This impact could also be as a result of population migration thus transhumance of vectors to the project area or it could be brought through hygiene conditions at the farmland. Thus the disease most likely to relate to the impact of the project will mostly be malaria. This impact will also manifest in case of poor soil drainage, lack of drainage canals or badly designed and/or maintained, are constructed, if borrow pits are left with stagnant water or canals are unlined and have unchecked vegetation growth. This impact will occur in the general project area as many of the settlements are located on higher grounds near the project site.

Mitigation

The control of the water-related diseases will be conducted in a number of ways, some of which are mutually reinforcing. The following measures are proposed to mitigate this impact.

1. Measures aimed at the pathogens: immunization, prophylactic or curative drugs;
2. Introduction of fish in the canals to destroy vector larvae;
3. Undertaking health education, personal protection measures including mosquito nets and mosquito proofing of houses;
4. Management of the irrigation infrastructure;
5. Indoor residual spraying
6. Provision of farm toilets in the blocks

To achieve the above conditions, the farmers should prevent or remove aquatic vegetation, lining canals with cement or plastic, regularly fluctuating water levels, periodic rapid drying of irrigation canals, preventing contamination of water bodies with faeces, supply of safe and clean drinking water, appropriate siting of housing of the farmers etc.

For malaria prevention measures, introduction of fish in the canals would destroy the larvae which act as the breeding ground. Fish species that can be introduced and which are commonly cultured include *Tilapia melanopleura* (it may be *T. rendalli* and not the true *T. melanopleura*) and *T. macrochir*. *Tilapia nilotica*, *Clarias carsonii*, *C. mossambica* and *Serranochromis macrocephala*. This measure will also serve as incentive as a supply of rich source of protein.

Control of vectors in the irrigation channels will require frequent flushing of the canals during wet season when water volume is high. This can be best guaranteed during the rainy season when flushing is aided by excessive amounts of precipitation.

8.2.3.3 Population Migration

Due to minimal economic activities other than subsistence agriculture and livestock keeping, many people have moved from rural settings to urban centres in search of employment. With increased socioeconomic activities and increase income from existence of project there is set to be increase in population of people within the catchments. The operationalization of the project will attract people to those areas in search for employment and settlement. The effect of this impact will be felt in the health sector through increased rates of HIV/AIDs infection and other diseases that are spread through demographic changes and in environmental sector in terms of degradation. This impact will put pressure on social facilities including health care, water, energy, sanitation and land.

This indirect impact could also lead to degradation of marginal areas including hill sides, wetlands and forested areas through cultivation and as sources of fuel wood. Water resources will also be degraded through contamination with faecal matter as the area lacks sewer system.

The construction activities of sub project investments may require recruitment of “foreign” skilled and unskilled labour that could trigger conflict, resentment and tension by the local communities over perceived inequities in distribution of job opportunities by the local communities.

Managing Population Influx

There are no measures for preventing population influx into the project areas. However NIB and the government in these respective areas should control settlement in fragile areas including wetlands and steep hills through existing legislations such as the Water Act. Another measure to manage influx is through provision of social infrastructure including water and sanitation facilities. Sanitation facilities are particularly critical in the paddy areas as lack of them will result deteriorated water quality. During construction phase of the project, the contractors should have employment policy which gives preference to the local people. By employing the locals, this would discourage population influx to the area.

8.2.3.4 Safety Hazards

Risks to safety will be in two fronts. The first is during the project implementation phase. During construction of the irrigation infrastructure there is risk of injury to employees undertaking the work as well as community members around the construction activity especially small children. Injury or death could result from falling into excavated areas, drowning in flooded pit holes and canals as well as injury or death from vehicles, heavy machinery and equipment.

The second risk to human safety is during the operational phase. This entails falling into canals leading to injury or death due to drowning. This is an impact more prone to small children and to community members travelling during dark periods (at night) particularly when drunk.

Mitigation

It will be necessary for the project team to ensure that proper working equipment and attire are provided during the construction phase to minimize chances and incidences of death or injury. Similarly, proper warning signage should be appropriately erected especially where there are heavy machines and equipment moving or around excavated areas so as to forewarn any nearby persons of the dangers eminent. Intensive awareness programmes before and during the construction periods on public safety should be undertaken to reduce the chances of this impact manifesting. Where heavy or specialized equipment is in use, the project managers should ensure that it is only qualified personnel that are engaged and allowed to operate these. Strict measures should be provided to avoid unrestricted access to such.

During final project layout designs, the engineers should ensure that canals and feeder canals are well positioned to limit unnecessary exposure to the public. Where possible especially along footpaths and roads, buffers of natural bush should be erected so as to provide clear markings of where the canals are and therefore prevent accidents. Similarly, public awareness campaigns should be engendered into the project to ensure

that the public is aware of risks the canal pose and will therefore take precautionary measures when travelling or working near them.

8.2.3.5 Loss of Livelihoods

Current livelihood sources in the area are subsistence farming, livestock keeping and fishing. Increased acreage of irrigation will reduce opportunity for the other existing sources of livelihood in one way or another. As shown on section 4.3.2.2, one of the livelihood coping mechanisms of floods is livestock keeping. Irrigating 3500 ha, will reduce acreage available for livestock grazing thus endangering alternatives means of livelihood of the locals. This loss could be through reduced amounts of pasture land or negative impacts on fisheries as discussed in chapters before. The impact may also be felt where families are displaced to provide room for the project infrastructure and especially if the infrastructure cuts right through an area with an economic activity being undertaken. This impact will be of low incidence as irrigation activities will be undertaken by the communities residing in the area and will therefore provide alternative livelihood sources through actual farming, markets and employment.

Mitigation

Where it occurs displaced people should be compensated and given alternative areas for cultivation to cushion them against shocks such as hunger. The new areas should be developed for them or they should be integrated into the projects associations as they become projects beneficiaries and not losers.

Proper management of resources (soil and water) will ensure that aspects such as fisheries will not be adversely affected therefore reducing impact on that source of livelihood. This is important as fish is the key source of protein for not only the area but also as general region. It is critical therefore that this impact is adequately mitigated to safeguard this protein source.

8.2.3.6 Emergence of Pests and Crop Diseases

Increased acreage of irrigated land will create a more humid environment that may result in an increase of agricultural pests and plant diseases. Change to a more uniform environment on the project areas will favour vigorous species adapted to a wide variety of conditions. Diseases and weeds will spread quickly via the re-use of waste-water and drainage water. Some of the agricultural pests that may increase will mainly be birds and rats. Insects do not provide serious harm to rice like with other crops. Diseases will include rice blast caused by *P. Oryzae*, Sheath brown rot caused by *Pseudomonas fuscovaginae* and fungal disease caused by *Sarocladium oryzae* due to humidity added through increased evaporation in the paddies. The Rice Yellow mottle Virus is also another disease endemic to Africa. It gains access through grain or crop injury. It is a problem in paddy and lowland rice fields. Increase in pests and plant diseases will affect farm harvest and lead to food insecurity and malnutrition in western part of the country. Increased pests and crop diseases will trigger increased use of pesticides leading to water contamination.

Mitigation

To mitigate against emergence of pests and diseases an incorporation of IPM approaches are proposed. These measures should involve rotational/mixed cropping practices which preserve greater diversity in habitat thus reducing impact of pest and diseases. At the farm level, the agronomist should discourage monocropping. Rice varieties used in this project should be selected from the ones already introduced in Kenya and allowed by KEPHIS in order to avoid new diseases and pests.

8.2.3.7 Displacement

Displacement is defined here as referring to either physical, economic or cultural displacement (or deprivation). Acquisition of land for irrigation infrastructure, drainage and roads to the project sites will lead to displacement of the services that are provided by the area i.e. housing, grazing, growing fodder, source of domestic water and brick making. It is estimated that about 1,800 plots/parcels of land will be acquired. However even though this acquisition will be partial in most of these plots there will be somewhere the remaining plots will be uneconomically viable thus acquired fully. Approximately 1871 households will be affected by the project and a total of 135.3 hectares of land acquired for the project. Also at least 200 structures encompassing businesses, homesteads, latrines and community wells will also be acquired as a result of the project. The land size that will be acquired for the project is estimated to be about

Cultural displacement may also occur due to the project since its infrastructure targets areas used for residential purposes and also they traverse community settlements. Thus the project may result in the displacement of cultural resources either buried or established on the ground. The latter case may also involve areas used for cultural practices and customs whose use can be affected by the project.

Mitigation

The mitigation measures of this impact will be addressed in the Resettlement Action Plan (RAP) for compensating those who are displaced from the areas earmarked for development and construction of water infrastructure. The RAP will take into consideration the investment undertaken in the sites and alternative areas be identified for these people. Alternatively, the people who traditionally farmed the project area should be integrated into the project beneficiaries associations.

The RAP should consider resettling the displaced by providing land and investment and not just providing cash to the affected as this will create a squatter problem if the displaced misappropriate the money given as settlement for their land.

The project should also develop chance find procedures for displacement of cultural resources and it should do so in consultation with the community members and the National Museums of Kenya. The RAP should also include adequate mitigation measures, procedures and considerations for cultural heritage when encountered at the domestic and community level.

8.2.3.8 Food Security and Subsistence

The presences of Bunyala Irrigation Scheme within the project area will attract potential project beneficiaries to want to grow rice. With higher income as compared to other subsistence crops, subsistence farming might be abandoned in favour for cash flow rice. This trend might affect the production of food crops leading to food insecurity in the project area. While the country agricultural strategy and poverty reduction strategy promote high value crops, subsistence crops still play important role in ensuring food security for the majority of the rural poor. This is an indirect impact that might affect the whole country food security situation, more so because rice is not considered a staple food in Kenya though there is relatively high consumption.

Mitigation

This impact can be mitigated by good land use planning that incorporates rice production and other food crops. Agricultural extension officers should be mobilized to advice farmers on the importance of diversifying crop production and good farm practices such as intercropping, rotational cropping and agro forestry. The project proponents should also embark on encouraging communities to diversify their staple diet so that they do not only rely on traditional food crops as their most important crop even when it has little economic returns. When rice is out of season, irrigation blocks can be cultivated with fast growing seasonal crops which would provide alternative foods for the communities in the area. This will ensure that within the project area there is food available for local consumption.

8.2.3.9 Movement obstruction due to construction of canals

The creation of canals and feeder canals within the project area will obstruct movement within and without villages and homesteads and make it difficult for movement of people and goods as well as livestock. It will also provide for limitation in accessing social amenities such as schools and medical facilities.

Mitigation

The project design should ensure that existing transportation and communication routes as well as new appropriate ones are adequately covered using culvert. This will ensure that communities and families are not cut off from their friends and relatives. It is also ensure that populations in the area can access social amenities without difficulty. In public areas, culverts should be provided to ease access by people and livestock. In areas where canals and drains will pass near homesteads, culverts should be used.

8.2.3.10 Child Labour & Low Education Levels

Rice cultivation is a labour intensive activity and in areas of the north where they have been cultivating rice before, most of the members of the households engage in rice cultivation and this could result in drop in school attendance as children provide labour in the paddies. This impact will be more so in poor households that cannot afford to employ additional labour. This impact will not be significant as the government policy on free primary education is compulsory and is punishable. However even with the free primary policy, in interiors of the country where close supervision is not strict, children will forgo school to work in the rice paddies. This trend was witnessed in other rice

growing areas of Kenya where children opt to working in the fields due to the quick money as shown in section 5.3.7 on literacy levels in the project area.

Mitigation

Application and strict enforcement of the compulsory free primary education will help to reduce the impact. Also through creating awareness of the importance of education, the beneficiaries should help prevent the impact from occurring. NIB should educate the IWUAs members to avoid use of children labour during school days. The local administration (chiefs) should enforce of the policy on use of child labour at the project level.

8.2.3.11 Water and Sanitation Impacts

The return flow from the irrigation paddies will have impact on human health for those villages downstream that use the flood water for domestic uses. This is because the return flows will likely to have significant quantities of pollutants from agrochemicals. This is a cumulative impact as the water from the Nzoia River is already contaminated upstream and may be unfit for human consumption. The primary health concern regarding nitrate and nitrite is the formation of methaemoglobinaemia, so-called “blue-baby syndrome.” Nitrate is reduced to nitrite in the stomach of infants, and nitrite is able to oxidize haemoglobin (Hb) to methaemoglobin (metHb), which is unable to transport oxygen around the body. The reduced oxygen transport becomes clinically manifest when metHb concentrations reach 10% or more of normal Hb concentrations; the condition, called methaemoglobinaemia, causes cyanosis and, at higher concentrations, asphyxia. The normal metHb level in infants under 3 months of age is less than 3%.

Mitigation

NIB in consultation with the local community should provide domestic sources of water during the planning phase of the project. Within every block, there should be provision of safe water supply. The return water flow should pass through buffer zones to enable filtration of agrochemical pollutants to a degree that is fit for domestic use or near the level as required by (WHO) World Health Organization standards⁵.

8.2.3.12 Human Wildlife Conflict

The presence of warthogs and hippos in the wetlands of Lake Victoria and Yala swamp will cause human wildlife conflict brought about by crop farms that will be most of the dry season green. This is an impact that is already being felt by the residents of the project area. This will be cumulative impact to the area as there is an existing human wildlife conflict.

Mitigation

To prevent the hippos from invading the irrigated blocks, a trench should be dug along the southern boundary of the project area. A five metre wide trench is proposed. This

⁵ World Health Organizations drinking water standards are 0.2 mg/litre for nitrate ion, 1500 mg/litre for potassium or other TDS as a maximum allowable or permissible concentration, optimum pH ranging between 6.5–9.5.

measure should be undertaken in consultation with Kenya Wildlife Service (KWS). The design has incorporated a major drain on the southern boundary of the project area. This drainage could also act as a barrier to prevent hippos from crossing over to the irrigated fields.

8.2.3.13 Noise and Vibration Impacts

Construction activities could result in significant noise impacts so as to impact on general well-being, health and functioning. Large scale infrastructure developments involve the use of heavy equipment (graders, drilling equipment, trucks, blasting equipment, tractors, and excavators) for among others rock blasting, excavation, asphalt mixing plant operations and vehicular movement that emit incessant noise usually harmful to the environment. Introduction of new sources of noise is an issue in areas where ambient noise levels have been low.

Mitigation

This impact is unavoidable and will be mitigated using machinery that minimise noise emissions, construction will be avoided at night.

8.2.3.14 Land Use Change

The project area is fallow with areas that are submerged with flood water. The change of the area from fallow state to irrigated field will lead to change land. Cumulatively, a total of 3500 hectares of farmland and fallow areas will be irrigated. This is a permanent impact. However, the area can revert back to its status after decommissioning of the project but it will take a long period of time before the rejuvenation.

Mitigation

This impact is unavoidable and can only be compensated through allocating those who will be displaced from their farms and leaving part of the project area fallow for grazing and firewood supply.

8.2.3.15 CUMULATIVE IMPACTS

Water abstraction from the Nzoia River for the scheme will marginally reduce the net water volume available in the River (because of consumptive use by crops). In itself, this will not affect downstream water users significantly. However, when combined with other existing and planned water abstractions from the River Nzoia, it will contribute to significant impacts on overall water availability in the sub-basin in dry years.

Abstraction of water from the Nzoia River combined with other irrigation schemes within the same River will cumulatively impact on the hydrology of the River especially downstream and an Environmental Flow Analysis (EFA) is required in order to determine the overall of all the irrigation projects on the Nzoia River and its capacity as a tributary to the Lake Victoria Basin.

There are a number of irrigation schemes in the project districts including Bunyala Rice Scheme, Rwambwa Mudembi, Nahasyongo Muluwa, Muuri, Neboka, Bubasi, Munaka, Yala Swamp, Syamungu and Busagwa. In the project area the major existing irrigation scheme is the Bunyala irrigation scheme (280ha) which is under the management of the

NIB. Altogether these schemes are currently cultivating about 700 acres of rice but at different times of the year.

In terms of water use by the communities along River Nzoia, abstraction of water for irrigation combined with other on-going abstraction projects may cause adverse impacts and conflicts by communities who depend on the water for domestic purposes. Especially the populations living downstream whose livelihoods may be affected by dam-induced alterations of river flows especially during the dry season.

The river-dependent populations located downstream of the weir (*segment of the human population that depends very directly on aspects of the river ecosystem that are sustained by particular patterns of river flow - the highs and lows, floods and droughts - that Nzoia river exhibits in its relatively natural state*) are likely to commonly experience a difficult upheaval of their livelihoods, loss of food security. While the downstream river-dependent communities may benefit from some degree of flood protection and enhanced irrigation opportunities provided by the dam (Nzoia River seasonally burst its banks causing flooding downstream), the adverse impacts are likely to be far more common and could outweigh the benefits to downstream people, resulting in reduction of their incomes and livelihoods especially during the dry seasons.

The most common and most threatening impact will be the loss of food security that stems from changes in the flow regime - especially the loss of seasonal flooding. Seasonal floods hydraulically connect a river with the surrounding landscape, promoting the exchange of water, nutrients and organisms among a rich mosaic of habitats. This river-flood-plain connection increases both species-diversity and biological productivity. The moist, naturally fertilised flood-plain soils also allow for sustainable cropping systems that provide food during the drier months. Herders also look to flood-plains for water and grazing areas for their livestock during the dry season. Without the influx of water and nutrients in this annual cycle of flooding, these flood-plain production systems can disappear, taking with them human livelihoods.

Mitigation-Maintain 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 valued features of the ecosystem. (McCartney et al. 2008). As described in earlier sections of this report the environmental flows calculation should be adhered to.

Table 26: Summary of adverse impacts characteristics

Impact	Extent	Occurrence	Significance	Nature	Mitigation
Water wastage	Riverine	Certain	Low	Cumulative	Lining of canals and drains
Changes in Hydrology	Lower Nzoia Basin Domestic water	Potential	Medium	Cumulative	Control and management of abstraction
Soil erosion	Site specific	Potential	Low	Cumulative	Soil conservation measures
Water logging and salinization	Site specific	Certain	Low	Cumulative	Plant deep rooted crops. Lining of canals in areas not submerged
Surface Water Resource pollution	Lower Nzoia Basin Domestic water	Potential	Low	Cumulative	Training and practice IPM and rational application of fertilizer
Sub-surface water contamination	Site specific	Potential	Medium	Cumulative	Adoption of IPM, rational application of agrochemicals
Soil salinity	Site specific	Potential	Medium	Cumulative	Create adequate drainage/frequent flushing
Reduced water flow downstream	Downstream	Potential	Low	Cumulative	Regulate water abstraction at not more than 20% of the discharge
Flooding	Downstream	Potential	High	Cumulative	Creation of buffer areas and regulate abstraction
Micro climate modification	Site specific	Certain	Low	Indirect	Promote woodlots around the fields and homestead
Greenhouse Gas emission	Site specific	Certain	Low	Cumulative	Removal of vegetation after harvesting
Siltation of water bodies	Downstream	Potential	Low	Cumulative	Catchment conservation
Population influx	Project area	Certain	Low	Indirect	Managing population by protecting fragile areas and provision of basic amenities

National Irrigation Board

Impact	Extent	Occurrence	Significance	Nature	Mitigation
Encroachment into Yala swamp by out growers	Area specific	Potential	Medium	Indirect	Creation of buffer zone along the border of the project area and Yala swamp
Birdlife poisoning	Localised	Potential	Medium	Cumulative	Ban use of toxic agrochemicals such as furadan
Water weeds infestation	Site specific	Potential	Low	Indirect	Proper use of agrochemicals. The canals gradient should be enhanced to increase water flow. Flushing of the canals and drains
Water borne diseases	Localised	Potential	Low	Cumulative	Introduction of fish in the canals and awareness creation Provide safe drinking water sources
Safety hazards	Canals	Potential	Medium	Indirect	Provision of community watering points and culvert public areas
Emergence of diseases and pests	Regional	Potential	Low	Indirect	Intercropping and rotational cropping
Movement obstruction due to construction of canals for both animals and human	Site specific	Certain	Medium	Direct	Use of culverts and construction of access roads
Food security and subsistence	Regional	Potential	Low	Indirect	Promote intercropping and rotational farming
Child Labour	Localised	Certain	Low	Indirect	Enforcement of free primary education policy
Displacement	Localised	Certain	Low	Direct	Use of 50m wetland allowance for access and compensate the displaced
Loss of livelihoods	Localised	Potential	Low	Direct	Compensate as per the RAP
Human Wildlife Conflict	Localised	Certain	High	Cumulative	Provision of a trench running on the southern part of the project area

National Irrigation Board

Impact	Extent	Occurrence	Significance	Nature	Mitigation
Land Use change	Localised	Certain	Medium	Cumulative	None

9 PROJECT ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

This ESMP is a detailed program of work which defines what mitigation measures and monitoring activities that will take place, when and by whom. The plan includes estimates of costs of implementation. The persons and institutions responsible for implementing the plan will include farmers/water users associations NIB, NEMA, World Bank, Ministry of Agriculture and contractors. Potential mitigation measures considered in the Environmental Social Management Plan (ESMP) include:

- Environmental management plans and programmes;
- Social and economic investment programmes;
- Engineering design solutions;
- Alternative approaches and methods to achieving an activity's objective;
- Operational control procedures; and
- Management systems approach.

9.1 ESMP OBJECTIVES

The objectives of the Environmental and Social Management Plan (ESMP) are:

1. To bring the project into compliance with applicable national environmental and social legal requirements and the World Bank's environmental and social policies as stipulated under the various safeguard operational policies and Bank procedures;
2. To outline the mitigating/enhancing, monitoring, consultative and institutional measures required to prevent, minimize, mitigate or compensate for adverse environmental and social impacts and/or to enhance the project beneficial impacts;
3. To address capacity building requirements to strengthen the Proponent's environmental and social capacities if necessary.

9.2 ESMP IMPLEMENTATION

It is proposed that NIB will be the executing agency for the project construction with the General Manager taking the role of execution. In view of the current status of manpower within the NIB, it will be advisable to establish a project management office that will directly be controlled by project coordinator. An independent project coordinator will control, manage, and operate the project office. The project implementation unit will be based in Bunyala irrigation Scheme under the NIB. It will basically have its own staff for project coordination, administration and technical field coordination. To create impact, technical assistance will be required for the management (IWUA & crop selection) of the system and the farming community in the initial stages. The staff will need the support of a consultant for the main infrastructure, infield and the irrigation management.

This ESMP will be implemented by several institutions which are directly or indirectly involved in this project. These institutions are the World Bank as the lender, NIB as the project implementer or proponent, MoH, MoA, MoL, WRMA, IWUAs members, design engineers, contractors who will be commissioned to construct the irrigation

infrastructure. However the overall responsibility for compliance with the environmental management plan rests with the project proponent (NIB).

9.2.1 World Bank

World Bank will undertake periodic monitoring of the implementation of the ESMP during the appraisal and review missions at least twice every year.

9.2.2 National Irrigation Board

NIB is the lead agency in the implementation of this ESMP and the project. The role of NIB will be to implement mitigation measures, coordination of ESMP and monitoring activities maintenance of monitoring information, building the capacity of other stakeholders in collection and analysis of monitoring data. The Environmental Officer from NIB will be the focal point for the ESMP and will liaise with other stakeholders to execute the plan.

9.2.2.1 Project Management Unit (PMU)

For effective management of the project, a PMU will be established that will compose of the stakeholders identified in the ESMP. This PMU will be meeting at the project location to address the issues that will arise during the project implementation.

The PMU will comprise a project manager; a deputy manager/irrigation agronomist; an irrigation engineer; a community development officer; and an agricultural marketing officer; together with administrative, accounting and procurement staff. As stages of the scheme are completed, further staff would join to manage operations, including a number (eventually 10) of irrigation technicians. Specialist consultants will support the PMU, including: an M&E consultant to collect data to transfer to NIB HQ, which will be responsible for overall project M&E; and a social/environmental safeguards specialist for implementation of the Environmental and Social Management Plan (ESMP), working under the supervision of NIB HQ, which will be responsible for overall implementation of the ESMP and for reporting on the respect of safeguards.

9.2.2.2 Role of other stakeholders in the PMU

In addition to the NIB PMU and the IWUAs, membership would include - on an *as needed basis* - local representatives of agencies key to project implementation:

- The County Administration, which will need to support community mobilization and the process of IWUA formation
- The District Irrigation Officer, to support the irrigation development and water management activities
- The District Gender and Social Development Office which will support the formation of the IWUAs and be responsible for their registration
- The District Health Officer, whose support will be essential to the implementation of the health activities under the ESMP
- The District Engineer, to coordinate the development of road infrastructure linked to the scheme roads network
- The local NEMA Branch, to support implementation of the ESMP
- The District Lands Office, to accompany implementation of the RAP

- The District Agriculture Office, to support the agricultural development programme and to coordinate implementation of the watershed protection activities in the ESMP
- NGOs and CBOs locally active in relevant fields would also be invited to attend.

9.2.3 Ministry of Agriculture

The District Agricultural Office is mandated to coordinate and supervise agricultural activities and to provide extension services to farmers in the district. In direct relation with the MIS, the agricultural office is concerned with the control of Quelea birds, which are the major rice pests. Apart from control of Quelea birds, the DAO has limited contributions to the operations of the scheme.

Therefore it is put forth that the Ministry of Agriculture along with NIB will liaise to provide extension services to farmers in IPM, fertilizer and pesticide management and efficient utilization of irrigation water. This will be undertaken through the extension services framework. The NIB-agronomist will be the focal point for training in IMP and agrochemical application and will liaise with the District Agricultural Officers for technical support. It should be noted that all the capacity building activities should be hands-on through the farmer's field day approach. The project should establish a farm in each section of the project area which will act as the field school.

9.2.3.1 Training in IPM, Fertilizer and Pesticides Application

The training objective is to ensure that beneficiary farmers in the project area do not pollute water resources through unsustainable application of inorganic fertilizers. This capacity building activity can be undertaken by Ministry of Agriculture through the National Agriculture and Livestock Extension Programme (NALEP) as well as the National Irrigation Board.

9.2.3.2 Efficient Water Use

Inefficient use of water in the irrigation scheme could cause water logging, increased health concerns and loss of water downstream. The NIB-Irrigation engineer will coordinate training in efficient irrigation water uses including when to flood the paddies and when to drain.

9.2.4 National Environment Management Authority

National Environment Management Authority being the oversight authority over the environment in Kenya, its role will be reviewing of the ESMP, approval, monitoring of environment indicators as identified in this monitoring plan and advising on environmental issues related to this ESMP.

9.2.5 Project Beneficiaries

The project beneficiaries being the people on the ground will have the role of executing some of the mitigation measures, collecting and monitoring the identified indicators and practicing sustainable farming as well as catchment rehabilitation and management. The project beneficiaries are organized in Irrigation Water Users and the Water Users

Associations which have management committees for water, production and maintenance.

9.2.6 Water Resources Management Authority

NIB in consultation with Water Resources Management Authority will develop an integrated catchment management plan for the project area. The integrated catchment management and restoration will involve soil erosion through afforestation, soil and conservation measures including terracing and agro-forestry on the sloppy areas.

A catchment approach would best mitigate environmental problems. The main elements of a catchment approach are to (i) buffer zones of natural vegetation created at intervals to control water flow, reduce downstream impact, help filter out effluents from other activities, and provide fodder for livestock and materials for thatch; and (ii) zoning of areas and restricting cultivation of habitats that are critical for water storage or breeding habitats for wild animals.

Water Resources Management Authority will also provide water abstraction permit based on the sustainable environmental flow of Nzoia River. They will also monitor abstraction rates as well as water quality draining from the farms into receiving environment to conform to the water permit.

9.2.7 Contractors

The contractors will be in charge of designing and constructing the infrastructure according to the findings and recommendations of this ESIA report and the ESMP, restoring the degraded areas, ensuring the safety of the users and others. The contractor(s) will be responsible for the complete implementation of design mitigation measures in the ESMP.

9.2.8 Ministry of Health

Due to existing health impacts especially malaria and bilharzias in and around the project area, the role of Ministry of Public Health and Sanitation will be to promote environmental health, health prevention methods including sleeping in treated nets, indoor residual spraying and monitoring incidences of malaria, cholera and bilharzias.

9.2.9 Ministry of Education

Monitoring and enforcement of the use child labour in the farms will be the responsibility of the ministry of education. This will be done through review of school attendance register especially during the land preparation and harvest seasons as this is the time when this impact will be occur.

PLANNING AND DESIGN PHASE

Activity	Adverse Impacts	Reference section	Mitigation Measure(s)	Implementation Schedule	Responsibility	Budget (US\$)
Site Selection	Displacement	7.2.3.7	Compensate the displaced persons according to WB policy on involuntary resettlement	Planning stages	NIB	2,000,000,000
	Land use change	7.2.3.13	Provision in the design a percentage of the project area to remain fallow	Planning stages	NIB is the lead agency and design engineers	Part of project preparation costs
Land Acquisition	Livelihood disruption	6.3.2.5	Compensation and allocated alternative sites (Need for Resettlement Action Plan and Resettlement Policy Framework)	Planning stages	NIB is the lead agency, Ministry of Lands and I&APs	2,000,000,000)
	Land speculation		Integrated in the project beneficiaries' association	Planning phase		
			Sensitization of the community members and let the community members buy-in the project			

CONSTRUCTION PHASE

Activity	Adverse Impacts	Reference section	Mitigation Measure(s)	Implementation Schedule	Responsibility	Budget (US\$)
Construction of irrigation canals, drainage and networks	Land displacement	7.2.3.7	Compensate the displaced persons according to WB policy on involuntary resettlement	Planning	NIB	
	Movement obstruction due to construction of canals for both animals and human	7.2.3.9	Use of culverts and construction of access roads	During construction phase	Project designer and contractor	
Civil Works: Removal/destruction of all vegetation from the project site/Site clearing /earth moving	Microclimate modification	7.2.1.9	Minimize extent of disturbance and protect and conserve project area downstream	During construction	NIB lead agency to guide the contractor	None
			Planting trees to restore ambient climate			
	Changes in hydrology	7.2.1.2	Maximise on return flow to the river by reducing water loss through seepage by lining the canals and drains	Planning stages	NIB leading agency and design engineers	Part of the 237 Million Construction costs
	Topsoil stock piles and excavation waste	7.2.1.10	Secure stock piles through installation of soil traps	During construction	Contractor	Part of 18 Million sedimentation Basin
Reuse the overburden earth to rehabilitate stripped and excavated zones and to fill the						

National Irrigation Board

Activity	Adverse Impacts	Reference section	Mitigation Measure(s)	Implementation Schedule	Responsibility	Budget (US\$)
	Soil erosion	7.2.1.3	burrows Avoid vegetation clearance where possible especially along the Nzoia river banks Revegetating of cleared sites with local species of vegetation Create contour drains during construction Management strategies to include terracing of sloppy areas, creation of erosion berms and planting Napier grass along canals	Construction and operational stages	Contractor	
	Resource use conflict over crop cultivation verses livestock grazing areas	7.2.3.1	Intensive extension services for improved livestock keeping such as zero grazing Provide grazing areas within the project blocks	Planning and operational stages	NIB lead agency and Design Engineers	None
	Siltation	6.2.1.13	Catchment rehabilitation and management	Continuous	WRMA	18 Million

National Irrigation Board

Activity	Adverse Impacts	Reference section	Mitigation Measure(s)	Implementation Schedule	Responsibility	Budget (US\$)
			Upstream afforestation for catchment protection Creation of buffer zones downstream Creation of Sedimentation Basin			
Construction of the weir	Flooding upstream	7.2.1.8	Flooding of the surface area of 379789m ² upstream should only be along the river course to avoid land inundation upstream. To avoid this, the weir should have overflow spillway.	Planning phase	Design engineers	237 Million

OPERATION PHASE

Activity	Adverse Impacts	Reference section	Mitigation Measures	Implementation Schedule	Responsibility	Budget (US\$)
Irrigation	Water wastage	6.2.1.1	Line transfer canals	Construction and Operational phases	Designers	Part of the construction costs & capacity building budget for IWUAs
			Water abstraction fees	Operational phase	NIB to facilitate payment of fees to WRMA by IWUAs	Part of the 41 Million set for O&M costs
	Encroachment into marginal sensitive Yala swamp	7.2.2.2	Provide buffer zone between the blocks and Yala swamp on the southern part of the project area	Design phase	Design engineers	Part of 918 Million for canal construction
	Soil salinization	7.2.1.4	Flush irrigated land regularly	Operational phase	IWUAs	Part of the 41 Million set for O&M costs
	Malaria as a result of mosquitoes breeding in the canals and drains	7.3.2.2	At the design stage the canals and drains gradient should allow faster flow of water (the land slopes 2%. The canals and drains should slope more than 2%)	Continuous	Design engineers for design work.	50,000 for TBNs
					NIB to facilitate Ministry of Public	

National Irrigation Board

Activity	Adverse Impacts	Reference section	Mitigation Measures	Implementation Schedule	Responsibility	Budget (US\$)	
	Changes in hydrology	7.2.1.2	Create awareness on malaria prevention methods		Health		
			Provide treated mosquito nets				
			Indoor residual spraying in homesteads around the project area	Operational phase	Ministry of Health		Part of MOH budget
			Control water abstraction by installing water meter and abstracting not more than 20% of the river discharge	Operational phase	WRMA		None
	Soil Erosion	7.2.1.3	Terracing of the sloppy areas of the land and planting of Napier grass along the canals	Continuous	IWUA	Part of 18 Million for sedimentation	
			Contour drainage to slow down surface runoff				
Reduced water flow downstream	7.2.1.7	Regulate water abstraction through practices	During design, construction and operation phases	WRMA to control IWUA members	Part of the 237 Million for Weir Construction Costs		
		Control abstraction rates by observing environmental flows calculations					

National Irrigation Board

Activity	Adverse Impacts	Reference section	Mitigation Measures	Implementation Schedule	Responsibility	Budget (US\$)
	Microclimate modification	6.2.1.9	Install master meters Proper design and operation of spillways and gates (timing and volume of discharges) Minimize extent of disturbance Planting trees to restore ambient climate	Design phase Construction and operational phase	Design engineers Contractor and IWUAs during operation	500,000
	Water-borne diseases	7.2.3.2	Prevent or remove aquatic vegetation Line canals Regularly fluctuating water levels. Provide domestic water point in all the blocks	Construction and Operational phase	NIB, Contractor, project beneficiaries and Ministry of Health	100,000

National Irrigation Board

Activity	Adverse Impacts	Reference section	Mitigation Measures	Implementation Schedule	Responsibility	Budget (US\$)
Application of agrochemicals (fertilizer and pesticides)	Resource Use Conflict (grazing, cultivation and water abstraction)	7.2.3.1	Supply of safe and clean drinking water	Operational phase	NIB to facilitate Ministries of Agriculture and Livestock Development	None
			Intensive extension services for improved livestock keeping			
	Water pollution	7.2.1.5	Provide in the blocks fallow areas where grazing should be undertaken	Operational phase of the project	NIB, MOA, and MOW&I	Part of 470 Million for Agriculture and Value Chain Component
			Adoption of IPM strategy			
	Loss of livelihoods	7.2.3.5	Provide domestic water points in the blocks	Planning stages	NIB to facilitate the Ministry of Agriculture through NALEP	Total Cost for implementing RAP is 2,000,000
			Compensate loss of farming land and crops			
Emergence of pests	7.2.3.6	Integrate the other food crops in the irrigated blocks	Operation phase		Part of 470	
		IPM approaches are proposed.				

National Irrigation Board

Activity	Adverse Impacts	Reference section	Mitigation Measures	Implementation Schedule	Responsibility	Budget (US\$)
	and crop diseases		Adopt mixed cropping practices. At the farm level, the agronomist should discourage monocropping.			Million for Agriculture and Value Chain Component
	Birdlife poisoning	7.2.2.3	Adoption of IPM strategy	Operational phase	NIB to facilitate IWUAs members	Part of 470 Million for Agriculture and Value Chain Component
	Water resources pollution	7.2.1.6	A training program on application of agro-chemicals under field conditions. Adopt Integrated Pest Management approach Create buffer zones downstream and draining of the irrigation water into wetland Identification and protection of domestic sources of water	Planning and operation stages	NIB to facilitate the WRMA and Ministry of Agriculture	Part of 470 Million for Agriculture and Value Chain Component

National Irrigation Board

Activity	Adverse Impacts	Reference section	Mitigation Measures	Implementation Schedule	Responsibility	Budget (US\$)
	Soil erosion	7.2.1.3	Terracing of the sloppy areas of the land and planting of Napier grass along the canals. Contour drainage to slow down surface runoff. Land levelling to prevent erosion	Operational phase	NIB as the leading agency and construction contractor	
	Displacement of staple food crops in favour of high economic value rice	7.2.3.8	Promote cultivation of food crops Agricultural extension officers to promote importance of diversifying crop production and good farm practices such as intercropping and rotational cropping	Planning and Operational stages	Ministry of Agriculture	Part of 470 Million for Agriculture and Value Chain Component
	Use of child labour	7.2.3.10	Enforce compulsory free primary education policy	Operation stages	IWUAs members to discourage and Ministry of Education to enforce	None
	Wildlife-human conflict	7.2.3.12	Provide for a 5 metre wide trench in the design on the southeast project area boundary	Design and construction phase	Design engineers in consultation with KWS	

DECOMMISSIONING PHASE

Activity	Adverse Impacts	Mitigation Measure(s)	Implementation Schedule	Responsibility	Budget (US\$)
Civil works	Burrow pits that could provide vectors habitat	Rehabilitate through levelling and planting of vegetation	During decommissioning construction	NIB	
	Abandoned canals could predispose farmers to hazards.	Fill or where otherwise level and introduce vegetation	During decommissioning	NIB	

10 MONITORING PLAN

This monitoring plan defines and identifies monitoring activities that will take place during development and implementation of the project. It defines timelines and responsibilities as well as identifies the indicators and data collection methods to be applied. The plan also identifies the training and capacity building needs of the institutions and persons to implement it.

As indicated in the monitoring schedule below, monitoring will be done by numerous institutions and persons but coordinated by environmental department of NIB while the focal person will be the Environmental Officer.

To ensure effective and reliable data collection, the key persons from the institutions to be involved in the monitoring will be trained on the indicators to be monitored, sampling methods, and data collection techniques to be used. The NIB environment department will organize a 2 day training program in one of the project sites and train the participants. The key resource persons for this training will be the Environmental Officer and the M&E coordinator. Participants for this training will be from the institutions involved in implementation of the monitoring plan which are NIB environment and social department, Environmental Officer, Agronomist, and Irrigation engineer, District Environmental Officer-Bunyala/Siaya, IWUAs members (farmers) from each irrigation blocks, District Agricultural Officer, District Water Officer, District Irrigation Officer and the District Public Health officer. **A sum of US\$ 210,000.00 should be allocated for purposes of monitoring and implementing mitigation measures as stipulated in the M & E Plan.**

It is critical that NIB coordinates with WRMA through the District Water Officer to monitor water abstraction and environmental flows so as to ensure that intended objectives of the project to conserve water through efficient water use are achieved. A regular log of water abstraction quantities should be kept at both offices.

The National Irrigation Board will facilitate their Environmental Officer or the District Environmental Officer to purchase sample collection equipment for water sample collection. Regular water quality sampling exercises will be undertaken. Monitoring data will be shared among the monitoring team to ensure that adopted mitigation activities are adequately addressed and implemented. As an example, water quality data should be shared with irrigation and agricultural officers to ensure that farming techniques such as application of fertilizers and pesticides has minimal impact on the quality of water.

During monitoring activities, NIB will regularly consult with the District Public Health Officer to obtain data on public health status especially on waterborne or water related diseases. Appropriate mitigation measures where necessary will be arrived at through consultations between the NIB Environmental Officer, NIB site engineer, District Public Health Officer and other related government officers as well as farmer leadership units.

National Irrigation Board

Monitoring, development of mitigation measures and implementation of the same should always include the farmer groups to improve rate of success and strengthen the environment management capacities of the farmers.

10.1 MONITORING SCHEDULE

Impact	Parameter	Indicator	Method	Frequency Measurement	of	Responsibility	Costs Estimates
Physical Environment							
Water pollution	Quality	Nutrients (Nitrates, phosphates, potassium, Ammonia ⁶ , pesticide residue, COD & BOD ⁷ , Turbidity, E-Coli	Quarterly during wet and dry season (samples should be taken from the inlet and outlet points of the developed area Incidences of water borne diseases	Seasonally quarterly	and	NIB, NEMA, DWO	100,000
Reduced Water flow	Quantity	Percentage of water abstracted to be kept, Adhere to Environmental Flows, Flow Rates Per Second	Water meter at the intake weir	Monthly		WRMA	WRMA already has a programme for water flow monitoring. 1000 Per Year
Water logging and soil salinization	Salt build up in soil	Soil salinity	Sample soil pH testing	Yearly		NIB and MOA	USD 20,000 for procurement of sampling kits

⁶ Free Ammonia (NH3): Less than 0.2 mg/l: The lethal concentration for a variety of fish species is in the range 0.2 to 2.0 mg/l NH 3

⁷ Biochemical Oxygen Demand (5-day at 20 °C): BOD is not a pollutant itself, but is a measure of organic pollution. Waters with BOD levels less than 4 mg/l are deemed clean while those with BOD more than 10 are considered polluted. High BOD concentrations may limit water use for public consumption, fisheries and irrigation.

Impact	Parameter	Indicator	Method	Frequency Measurement	of Responsibility	Costs Estimates
						and training of farmer units. ⁸
Soil erosion	Soil	Soil productivity, gullies, water turbidity, siltation of the canals, units and lines	Observation and look out for siltation and reduced retention capacity	Continuous	NIB and MOA	Should be integrated into cooperative activity collecting information from appointed members.
Water Wastage	Water Quantity	Abstraction quantities <i>vis a vis</i> water quantity requirements for irrigation	Abstraction Quantity Data	Monthly	NIB and WRMA	Water Flow Rates Data Collection Incorporated into WRMA water flow rates data acquisition. 30,000 for flow meter purchase
Biological Environment						

⁸ The farmer units should then be responsible for undertaking soil analysis on a yearly interval while NIB should collect and collate this data.

National Irrigation Board

Impact	Parameter	Indicator	Method	Frequency Measurement	of Responsibility	Costs Estimates
Encroachment into Yala swamp	Project area boundary	Project area boundary	Review of project boundary map	Seasonally	NIB and IWUAs	20,000
Birdlife poisoning	Poisoned birds	Bird deaths	Number of bird deaths	Daily	IWUAs and NEMA	10,000
Emergence of water weeds	Water weeds	Presence of water weeds	Water bodies with water weeds	Continuously	NIB and IWUAs	25,000
Socio-Economic Environment						
Emergence of pests and crop diseases	Pests and crop diseases	Signs of pests and diseases in crops/ Incidence and spread of pests and diseases	Incidence and spread of pests and diseases through Crop field assessment	Seasonally	District Agriculture Office & NIB	Part of the 470 Million for Agriculture and Value Chain
Child labour	School attendance	Number of school going children	School register	Continuous	MOE	Part of the 275 Million for Participatory Irrigation Management
Population influx	Population	Change in total human population within the 10 km radius of project area	Census reports	Continuous	Local Administration	Part of the 275 Million for Participatory Irrigation Management

National Irrigation Board

Impact	Parameter	Indicator	Method	Frequency Measurement	of Responsibility	Costs Estimates
Water-borne diseases	Water-borne diseases	Increased cases of malaria and bilharzias among other waterborne diseases	Review of health records at the divisional level health centres	Quarterly	NIB (Environmental Officer) Ministry of Health Public Health Office	50,000
Resource use conflict	Conflicts incidents	Complaints and reported cases of conflict	Review of complaints and conflicts	Quarterly	NIB –IWUA’s	USD 10,000. This can be channelled through the IWUA’s with oversight from NIB
Safety Hazard	Accidents	Incidences and accidents occurrences	Review and evaluation of incidents and accidents register	Monthly	NIB (Social Officer & IWUAs members	Part of the project M&E budget 5,000 per year
Food Insecurity	Food harvest amounts	Food crop production and acreage under food crops	Crop assessment reports	Seasonally	Ministry of Agriculture & NIB (can use FAO seasonal crop assessment data)	Part of the 470 Million for Agriculture and Value Chain
Movement obstruction	Complaints	Incidences and accidents occurrences	Review of complaints	Continuous	NIB and the contractor	50,000

National Irrigation Board

Impact	Parameter	Indicator	Method	Frequency Measurement	of Responsibility	Costs Estimates
Land Use Change	Change in land use	Project area boundary	Project area boundary review	Continuous		5,000
Human-wildlife conflict	Conflict	Incidents reported	Incidents review	Monthly	NIB, IWUAs and KWS	30,000

11 PROJECTS COST BENEFIT ANALYSIS

The emphasis of this chapter is the economic analysis of the proposed project. All the conventional economic and financial analyses to determine the best development option and the viability of the recommended alternative are considered and appropriate recommendations made. The economic value of the project to the beneficiary and the country is ascertained in terms of social enhancement, poverty reduction, food security, import substitutions, export earnings, recurrent expenditure (including O&M costs), etc. All capital, operation, maintenance and replacement costs are also calculated. The cost benefit ratio, internal rate of return and sensitivity analysis is also analysed.

The costs will be based on a replacement period of 4 years for electrical equipment, 8 years for the operation and maintenance equipment; 15 years for irrigation and drainage facilities made with concrete and a project life of 30 years. Discounting rates are to be used to examine the net present value for costs and benefits. The objective of the economic analysis is:

- Evaluation of the project contribution to the development of society
- Evaluation of the direct and indirect economic impacts, and qualitative estimation of the indirect economic benefits and costs
- Computation of the economic return of the proposed project, in comparisons with their costs along the time horizon of these projects.

11.1 FINANCIAL AND ECONOMIC EVALUATION

This is the second draft of the financial and economic analysis of the proposed Lower Nzoia Irrigation Project (LNIP) that would invest US\$44.6 million for developing about 4,000 ha under irrigation. According to this preliminary assessment exercise, if the project succeeds in transforming the existing 2,100 small farms currently under subsistence farming into the proposed cropping pattern with about 50 percent of the area under High Value Crops (HVC), beneficiaries would increase their income by six times today's level and the Economic Rate of Return (ERR) would reach about 15 percent.

The Lower Nzoia Irrigation Scheme will focus on improving agricultural production through the rehabilitation of the already existing Bunyala irrigation scheme (which covers 705 ha) and the expansion of the irrigated area by about 3,336 ha⁹. The scheme is located in the lower part of the left bank of the River Nzoia, and will benefit about 2,100 small farmers' households who hold an average of 1.92 ha of net irrigable area. The area has an average rainfall of about 900 - 1,500 mm per annum in a clear bimodal pattern concentrating heavy rains in May-June, and short rains in September-December. Temperatures range from 15oC and 30oC with an annual mean of 22oC. The evaporation rate is high ranging between 1,800 - 2,000 mm per year. This has created a great need for irrigation expansion. Water for supplemental irrigation will be provided

⁹ A Baseline Survey showed that two thirds of the farmers in the project area possessed documents to prove their land ownership while the other one third did not have these documents but it was understood that the land was communally owned and known as such while ownership was not in dispute.

by a gravity-fed surface system replacing the current pump fed system being used in the existing Bunyala irrigation scheme.

The project is designed to include three major components namely:

1. Component 1: Irrigation and drainage infrastructure (I&DI);
2. Component 2: Agricultural support and Chain Value (ASCV); and
3. Component 3: Participatory Irrigation Management (PIM).

The Agricultural support and Chain Value (ASCV) and the Participatory Irrigation Management (PIM) soft components together with the Irrigation and Drainage Infrastructure (I &DI) component will create the conditions for the transformation of the Lower Nzoia Irrigation Project area into an intensive and efficient irrigated production system. The ASCV component would assist in setting up and financing support to a sustainable and inclusive value chain development intended to help farmers not only to produce enough food for household consumption but also to grow and market high value crops and thus earn better and higher incomes. This would include extension services to farmers, timely access to agricultural inputs, linkages with private sector practitioners who are interested in the produce for agribusiness purposes, assistance to farmers in contracting with such entities, and promotion of System Rice Intensification (SRI) technologies in the proposed paddy rice areas. It would also include provision of some critical marketing and post-harvest structures such as packing, storage and processing facilities, together with capacity building for farmers and the National Irrigation Board (NIB) staff with needed training programs, study tours demonstration and exchange visits, etc. Land levelling will also be included as required as well other on-farm development works comprising the tertiary canal/water courses, feeder canals and on-farm irrigation structures.

Through the PIM component, the project will strengthen the system management by both NIB and farmers through their Irrigation Water Users Associations (IWUAs). The National Irrigation Board (NIB) would be responsible for managing the head works, main canal and its pertinent structures, while Irrigation Water User Associations (IWUA's) would manage the branch (secondary) canals, tertiary canals and other water courses. The IWUA's would be trained on all aspects allowing them to adequately play their role, alongside NIB: operation and maintenance (O&M), administration of financial matters related to collection of the irrigation water fee, water distribution, relations with various stakeholders; and to act as efficient intermediaries between NIB and farmers. The NIB would provide the needed technical support to farmers to ensure that the I&D system is managed properly. Members of IWUA's will pay the full cost of Operation and Maintenance (O&M) of their system and the corresponding water charges such as those payable to the Water Resources Management Authority (WRMA). The component will also include provisions for capacity building for farmers and NIB staff on water management as well as development of a Geographic Information System (GIS) for the IWUAs.

11.1.1 Methodology for Financial and Economic Analysis

With and without project scenarios were modelled to estimate the current and expected and thus the incremental benefits from the project. The total project area covering a

gross area of 5774.4 hectares and a net irrigable area of 4043 hectares is currently cropped with several upland crops in addition to the 705 hectares under the Bunyala irrigation scheme which are cropped with paddy rice. The scheme expected financial impact on farmer's income and the economic impact on the Kenyan economy were assessed with the help of crop and farm models showing the current farming situations and the possible changes planned to be introduced through the project support interventions. In determining the incremental benefits associated with the project, the current cropping patterns were combined with the current gross margins and the product subtracted from the expected benefits; calculated by combining the proposed cropped patterns and the expected gross margins.

The analysis has been conducted in both financial and economic prices. Financial prices used in the analysis farm gate prices for the various crops as collected from various and recent sources¹⁰ for purposes of the financial analysis. Border parity prices were used for conducting the economic analysis; particularly for those products that Kenya imports. These were preferred since they are free of distortions such as subsidies, taxes and other transfer payments within the Kenyan economy. Recent (September 2012), average world prices estimated by the World Bank were used for calculation of border parity prices. Conversion Factors (CF) were used to convert financial costs to their economic values based on the consultants' knowledge from similar projects in the region.

The detailed financial and economic analysis has been carried out using rather conservative assumptions on yield increases, crop intensities and partial diversification to High Value Crops (HVC). Produce prices were assumed to be those offered at the farm gate while a 30 year period was considered for the overall analysis.

The evaluation of the proposed Lower Nzoia irrigation project uses conventional cost-benefit analysis to measure the economic and financial performance of the proposed interventions. Financial analysis is undertaken so as to assess the degree to which the Lower Nzoia Irrigation Development Project will generate revenues sufficient to meet its financial obligations. On the other hand, the primary purpose of the economic evaluation is to assess the performance of the project according to accepted economic standards using an Economic Cost of Capital (ECOC) of 12%. In each case, the NPV, IRR and BC ratios are estimated.

11.1.2 Current Agricultural Production and Revenues

The area proposed for irrigation is located in both Bunyala and Siaya districts in Busia and Siaya Counties respectively. Without project, only 705 ha are being used for irrigation of rice in the Bunyala scheme. The other existing households in the project area practice subsistence farming, mainly intercropping cereals and pulses, and/or

¹⁰ Source includes the Ministry of Agriculture price data and the validated report for horticultural produce from the Horticultural Crops Development Authority (HCDA). Price data for the year 2011 were used.

maize and sorghum as a strategy to avoid complete losses due to droughts or water logging during dry and wet seasons respectively¹¹. Farmers typically have about 2 hectares of land mainly with natural grass and some food crops. Major crop enterprises are cereals such as maize, rice, sorghum and millet; Root crops such as cassava, arrow roots and sweet potatoes; Pulses such as green grams, beans, sesame (simsim) and groundnuts; industrial crops such as cotton and sunflower and horticultural crops which include tomatoes, cabbages, kales, onions and assorted local vegetables (amaranths, black night shades, spider weed etc.). These are grown under rain fed low productive conditions with little or no emphasis on commercial farming except for rice and limited horticultural products that are grown for income generation. Traditional cash crops are limited with farmers withdrawing from production of crops such as cotton mainly due to low producer prices, lack of markets and/or quality inputs like seed, and high incidence of pests and diseases. Production of groundnuts, horticultural crops, bananas, sugar cane, and even beans and maize are therefore becoming the alternative source of cash, but still limited due to lack of seed materials, sufficient rainfall and access to markets.

To estimate the current (without Project) benefits from the target project area, data from the respective districts was used where proportions of the areas under commonly produced crops were applied to determine the area under each crop within the target project area. Similarly, reported gross margins for the different crops in the two districts during the year 2011 were used.

Without the project, paddy rice is the main and almost only crop being irrigated, mainly within the existing Bunyala scheme. Since the Bunyala irrigation scheme already exists, it is assumed that production of paddy within the scheme will continue even while the rest of the project area is still under construction. The existing scheme will however, benefit from the gravity fed intake; significantly reducing operation and maintenance costs associated with pumping while with project, yields would improve through the extensive dissemination of the SRI technologies which worldwide has proven, also in Kenya, to increase significantly the productivity of water, soil and nutrients and, at the same time, reducing the amount of water used.¹²

For the other existing crops, the higher productivity will be attained through the introduction of irrigation in previously rain fed cultivated areas. Yield increases were estimated using rather conservative figures, since there are several examples where

¹¹ Sorghum is more drought resistant while maize can survive better under mild water logged conditions. Cassava is widely grown within the project area as an additional form of food security crop.

¹² By [2012](#), approximately 3,000 farmers have been trained in SRI methods in Kenya with adopters now numbering about 2,000 in four irrigation schemes (Ahero, West Kano, Bunyala and Mwea). BancyMati [reported](#) yields up to 9 t/ha have been achieved with Basmati rice and over 17t/ha for a high-yielding IR variety; water savings ranged from 25-33%, depending upon the season. An [article](#) published in the March 2012 edition of the *International Journal of Current Research and Review* showed water productivity (2.16 vs. 0.98 kilograms of rice per cubic meter of irrigation water supplied) averaging 120% higher for the three varieties under SRI management.

higher yields than those considered are being obtained in Kenya. This was to avoid overestimation of potential benefits.

11.1.3 Proposed Interventions and Project Components

As already mentioned the project aims to improve agricultural productivity at the farm level and thus increase food production and enhance household incomes. These will be achieved through development and expansion of irrigable area as well as support for marketing and value addition and support for management and capacity development. The proposed net irrigable area will cover a total area of 4043 hectares and will be implemented in four years starting with component 1. Several activities under components 2 and 3 are expected to be carried out concurrently with the construction of the scheme's irrigation and drainage infrastructure from the second year.

Farm production and income increases would result from improved water availability as irrigation infrastructure will rehabilitated and extended; which allows improving land and water productivity and from farming diversification towards HVCs as irrigation water become available and/or more reliable. Based on the topographical and farming systems, the project area was divided into 12 blocks. Blocks 1, 2, 3, and 7-12 are in Bunyala while Blocks 4, 5, 6 are in Siaya. For ease of conducting the analysis, the areas are generally termed as either Bunyala or Siaya blocks in the sections that follow.

In addition to irrigation and drainage infrastructures, capital expenditures will also include post-harvest handling facilities, agro processing facilities and farm machineries for undertaking major operations in the farms. These are in addition to institutional and capacity development for project implementation and for Irrigation Water User Associations (IWUA's). Project costs and expected benefits from the project are discussed in the sections that follow.

11.1.4 Project Cost

The total project investment costs comprise both investment and operation and maintenance costs. Investment costs are further divided depending on the three major components as described above. The total investment costs for the scheme is around **Kshs 4,210,686,864 (USD 49,537,493; 1 USD = Ksh 85)** of which the Irrigation and Drainage Infrastructure (I&DI) component would take 77.1 percent, the Agriculture Support and Chain Value (ASCV) 11.2 percent, the Participatory Irrigation Management (PIM) and Project Management component 11.7%. The cost per component is as follows:

Table 28: Summary Financial Investment Costs

Component	Kshs	USD
Component 1	3,248,186,864	38,213,963
Component 2	470,000,000	5,529,412
Component 3	492,500,000	5,794,118
TOTAL	4,210,686,864	49,537,493

11.1.5 Estimation of Project Benefits

In addition to the current project benefits, expected benefits (with project) and incremental benefits were estimated. Expected project benefits were estimated by combining the proposed cropping patterns and the expected gross margins from proposed crops.

11.1.6 Crop Budget, Prices and Yields

In estimating the crop budgets, detailed crop and agronomic activities, production levels and prices were prepared. Cropping patterns were prepared considering the land, soil, water and human resource situation Vis a Vis the proposed crops. Other considerations were the need for food security for the target households as well as the need for improved farm incomes through production of marketable high value crops. The availability of markets for the produce was also a major determinant for the choice of the crops.

The information required on yields and prices was obtained on data available from: (i) visits to farms in the lower Nzoia and similar areas in Kenya;(ii) data collected by the consultants preparing the pre-feasibility studies; and (iii) new data obtained during the preparation missions' field visits, and also from the MOA's statistics, Horticultural Crops Development Authority (HCDA) statistics and regional stakeholders' estimations and where necessary, financial produce prices for imported produce were adjusted to their economic values.

It is widely expected that farmers will not achieve the optimum yields from the onset of irrigated production but yields, particularly from annual crops, will gradually grow from 50% in the first year, 60% in the second year, 70% in the third year, 80% in the fourth year before stabilizing at 100% of optimal yields during and from the fifth year onwards. For perennials, mangoes are expected to reach optimal yields at the 8th year having started producing from the fourth year. Bananas will start production in the second year and reach optimal levels from the third year onwards. Pawpaws will start producing in the second year after planting, reach maximum in the third year; record decreased yields in the fourth year and be replaced with a new crop while passion fruits will be replaced after 3 years having reached potential yields in the second year.

In total fruit crops are expected to occupy about 30% of the total irrigable area. Amongst them, passion fruits and bananas will have the highest areas covering 10% each while mangoes and pawpaws will each cover 5% of the total area. Paddy rice will be produced in the low lying Bunyala blocks occupying 60% of the Bunyala blocks or 48% of the total irrigable area. Paddy yields are expected to double from the current 3,500 kgs to 7,000 kgs with better farming practices, enough water and adoption of SRI.

11.1.7 Crop Budgets

Crop budgets are presented in financial prices using current financial prices, and in economic prices using border-parity prices for the main traded crops and crop inputs based on the latest World Bank international commodity price projections of September 2012. An exchange rate of KES 85 = US\$1.0 is used.

Table 29: Summary of Crop budgets

Financial With Project					Economic With Project			
Crops	Income	Costs	Gross margin	GM US\$	Income	Costs	Gross margin	GM US\$
Cereals & Pulses								
Rice	294,000	82,896	211,104	2,484	228,501	79,354	149,146	1,755
Maize	152,000	58,818	93,182	1,096	120,292	61,656	58,636	690
Seed Maize	218,400	75,499	142,901	1,681	151,568	78,682	72,885	857
Soybean	105,000	47,701	57,299	674	100,608	48,270	52,339	616
Groundnuts	131,250	56,542	74,708	879	130,732	46,888	83,844	986
Greengrams	90,000	50,253	39,747	468	79,437	41,237	38,200	449
Vegetables								
Tomatoes	540,000	86,375	453,625	5,337	540,000	79,514	460,486	5,417
Onions	320,000	127,700	192,300	2,262	320,000	113,313	206,687	2,432
Water melons	221,000	75,055	145,945	1,717	221,000	70,054	150,946	1,776
Capsicums	360,000	106,600	253,400	2,981	360,000	72,991	287,009	3,377
Kales	130,000	61,484	68,516	806	130,000	59,497	70,503	829
Roots								
Sweet potatoes	155,500	59,750	95,750	1,126	155,500	50,050	105,450	1,241
Fruits								
Mango	550,000	80,368	469,633	5,525	440,000	76,485	363,515	4,277
Passion fruit	675,000	306,825	368,175	4,331	540,000	259,217	280,783	3,303
Banana	468,000	90,075	377,925	4,446	374,400	85,956	288,444	3,393
Pawpaws	550,000	84,750	463,600	5,454	440,000	77,997	362,003	4,259

11.1.8 Expected Agricultural benefits

Expected benefits are calculated by combining the expected gross margins with the proposed cropping pattern. These revenues change from one year to another depending on the cropping intensities and the proposed yield levels for that year. The scheme revenues are expected to stabilize from the 8th year onwards. A summary of expected revenues, both financial and economic, is summarized in **Table 30** below.

Table 30: Expected Agricultural benefits

Financial				
YEAR	Area (Ha)	Total scheme revenue- Financial	Total scheme costs - Financial	Total scheme gross margin-Financial
Total Year 1	5,699	513,994,548	435,283,372	(70,303,485)
Total Year 2	6,226	1,211,248,121	471,754,103	590,479,357
Total Year 3	6,833	1,419,759,615	510,776,520	759,968,434
Total Year 4	7,237	1,408,372,339	542,157,967	717,199,711
Total Year 5	7,237	1,775,747,288	542,157,967	1,084,574,660
Total Year 6	6,531	1,649,279,542	483,642,732	1,165,636,810
Total Year 7	7,237	1,680,736,788	542,157,967	989,564,160
Total Year 8 Onwards	7,237	1,975,875,788	542,157,967	1,284,703,160
Economic				
Crop	Area (Ha)	Total scheme revenue- Economic	Total scheme costs - Economic	Gross margin scheme-Economic
Total Year 1	5,699	421,056,577	411,173,225	(95,396,771)
Total Year 2	6,226	995,603,819	449,354,358	440,969,337
Total Year 3	6,833	1,190,025,324	500,533,563	584,211,636
Total Year 4	7,237	1,202,159,517	529,791,372	567,088,022

Total Year 5	7,237	1,516,107,135	706,880,361	703,946,650
Total Year 6	7,237	1,580,956,855	529,791,372	945,885,360
Total Year 7	7,237	1,440,098,735	529,791,372	805,027,240
Total Year 8 Onwards	7,237	1,641,258,996	495,407,268	1,040,777,555

The project's total expected benefits in financial terms is Kshs. 1.28 billion (USD 15.1 million) annually while economic benefits are Kshs1.04 billion annually (USD. 12.2 million). This translates to on average approximately Kshs. 317,760 per hectare per year (USD3, 738) in financial prices or Kshs. 257,427 (USD 3,029) per hectare per year in economic prices.

11.1.9 Incremental benefits

Incremental benefits were determined as the difference between the expected and the current benefits. Incremental benefits will result from increased irrigable area, increased productivity from better management practices, improved market access and support in marketing, agro-processing and value addition and the likely improvement in the farmers' share of benefits along the value chains. **Table 31** gives a summary of the incremental benefits from the proposed project in both financial and economic prices.

Similar to expected revenues, incremental benefits will increase gradually up to the eighth year, where the total incremental benefit in financial prices is Kshs. 1.18 Billion and Kshs. 0.96 Billion in economic prices. These are the gross benefits that have been used in the project.

Table 31: Project incremental benefits

Year	Financial (Kshs)			Economic (Kshs)		
	Expected	Current	Incremental	Expected	Current	Incremental
1	(70,303,485)	101,351,291	(171,654,776)	(95,396,771)	77,112,792	(172,509,563)
2	590,479,357	101,351,291	489,128,066	440,969,337	77,112,792	363,856,546
3	759,968,434	101,351,291	658,617,143	584,211,636	77,112,792	507,098,845
4	717,199,711	101,351,291	615,848,420	567,088,022	77,112,792	489,975,230
5	1,084,574,660	101,351,291	983,223,369	703,946,650	77,112,792	626,833,858
6	1,165,636,810	101,351,291	1,064,285,519	945,885,360	77,112,792	868,772,568
7	989,564,160	101,351,291	888,212,869	805,027,240	77,112,792	727,914,448
8	1,284,703,160	101,351,291	1,183,351,869	1,040,777,555	77,112,792	963,664,763

In addition to incremental benefits, project benefits from the currently irrigated areas are also included in the analysis. In total the annual gross revenues from the 705 hectares of paddy is Kshs. 149,014,661 in financial prices and Kshs. 105,280,124 in economic prices. The total benefits from the project area are thus Kshs. **1,332,366,530** in financial prices and **Kshs. 1,068,944,887** in economic prices.

11.1.10 Project Evaluation

The evaluation of the proposed Lower Nzoia Irrigation Project uses conventional cost-benefit analysis to measure the economic and financial performance of the proposed

interventions. Financial analysis uses discounted measures such as FNPV¹³, FIRR, B/C ratio and cash flow analysis. Financial analysis is undertaken so as to assess the degree to which the Lower Nzoia Irrigation Development Project will generate revenues sufficient to meet its financial obligations. On the other hand, the primary purpose of the economic evaluation is to assess the performance of the project according to accepted economic standards using an Economic Cost of Capital (ECOC) of 12%¹⁴ (as measured by the Economic Internal Rate of Return (EIRR), Benefit Cost Ratio (BCR) and Net Present Value (NPV). The economic and financial evaluation serves two main purposes i.e.:

- To show the economic performance and to assess ongoing sustainability and the implications for ongoing operation and maintenance of the irrigation infrastructure; and
- To show the financial impact of the proposed development on a typical agricultural project (whole project) and farm families to indicate returns to labor, profit and the economic and financial resilience and sustainability of the project.

11.1.11 Financial Analysis

As already mentioned, financial analysis uses the discounted measures such as the NPV the FIRR and the BC ratio. The following assumptions were made:

1. The project life is 30 years;
2. The financial cost of capital is 12%;
3. Prices are assumed to remain constant over the period;
4. There will be ready and consistent markets for the proposed products;
5. The project will be implemented in a total of four years starting with component 1 (three years) while component 2 and 3 will be implemented during the second, third and the fourth years.

The decision criteria is that for a project to be viable, the NPV should be positive while the FIRR should be greater than the assumed costs of capital; in this case 12%. Results for financial analysis shows that at the base case, the project has a positive NPV value of Kshs. **1,789,862,458** and an FIRR of **16.14%** which is higher than the Cost of capital, 12%. This suggests that the project is financially viable.

Additionally, the project's Benefit to Cost (BC) ratio is larger than 1 at 1.34 while the Net cash flows from the project are only negative during the first four years (the implementation period) after which they turn positive. This implies that the project is able to meet its financial obligations and even make a surplus cash flow once the scheme is fully operational.

¹³ The financial net present value is defined as the sum that results when the expected investment and operating costs of the project (suitably discounted) are deducted from the discounted value of the expected revenues.

¹⁴ Unless otherwise stated, the Economic Cost of Capital (ECOC) is conventionally assumed at 12%. Guidelines for the Economic Analysis of Projects, Economics and Development Resource Center, 1997.

11.1.12 Economic Analysis

The economic analysis appraises the project's contribution to the economic welfare of the region or country. It is made on behalf of the whole of society instead of just the owners of the infrastructure, as in the financial analysis. Similar to the financial analysis, the Economic Cost of Capital was assumed at 12%. However, financial prices and thus benefits and financial costs were converted to their economic equivalents¹⁵. Produce prices were converted to their economic equivalent by use of border prices for imported products. Other traded product prices were assumed to be 80% of their financial prices. Economic cost of labor was also valued at 80% of their financial costs while Conversion Factors (CFs) were used on financial investment and O&M costs.

11.1.13 Project Economic Cost

Conversion of financial costs to economic costs involved applying conversion factors (CF) to the individual or categories of financial costs to calculate their economic values. The CFs were based on the consultants experience with similar projects in Kenya and in the region. **Table 32** shows the conversion factors used.

Table 32: Economic conversion factors

Item	Conversion Factor
Civil works	0.95
Engineering services	1
On-farm irrigation system	0.9
O&M costs	0.85
Extension services	0.85
<i>Source: Consultants estimates</i>	

11.1.13.1 Economic prices and benefits

To convert financial to economic prices, economic border parity prices have been calculated for the main agricultural crops produced in Kenya for which there is a significant international trade and projections of their long-term price prospects are available. It is assumed that Kenya will continue to be a net importer of staple food stuff, consequently incremental production as a result of irrigation developed as a result of the Lower Nzoia Irrigation Project can be valued as an import substitute. It is assumed the imported product is through the port at Mombasa and delivered to Nairobi (the main centre of consumption) by road transport. Incremental production from the project area is assumed to be transported to major markets such as Busia, Kisumu and Nairobi to substitute for the imported products. Consequently, the farm gate price for production is net of the cost of transport from the production area to Nairobi.

The import price is based on the World Bank's commodity price forecasts of September 2012 which projects international prices for the main internationally traded commodities up to 2025. The price forecasts are calculated in both nominal (constant) prices to a year

¹⁵ See EC Working Document No 4, Guidance on the methodology for carrying out Cost-benefit analysis, available on URL:http://ec.europa.eu/regional_policy/sources/docoffic/working/sf2000_en.htm

2000 base, and current prices which allow for inflation according to the Manufacturers Unit Value Index (MUV) which is a measure of international inflation. For economic pricing, the World Bank forecasts in nominal prices are converted to a 2010 base year by applying a factor of 1.123 determined from the MUV index to allow for inflation from 2000 to 2025. In the calculation of the economic prices, all taxes and duties are excluded. For non-traded products and inputs, the economic prices are assumed at the same price as the financial prices. The economic cost of labour is assumed to be at 80% of the financial costs.

The calculated economic prices have been combined with the production levels to calculate total revenues after which production costs are subtracted to achieve the economic gross margins. Combining the economic gross margins with the current and the proposed cropping patterns yields current and expected benefits respectively. Incremental benefits are then calculated as the difference between the expected economic benefits and the current economic benefits.

11.1.13.2 Economic discount measures

The results for the economic analysis show that the Economic Net Present Value (ENPV) is positive at Ksh 1, 290,009,791 while the Economic Internal Rate of Return (EIRR) is 15.7%; which is higher than the assumed cost of capital of 12%. Further the BC ratio is 1.31 again higher than 1. These results suggests that the project is economically viable and sustainable as economic NPV is positive, EIRR higher than 12% and economic costs lower than the economic benefits as indicated by the BC ratio that is greater than 1. The positive economic cash flows suggest that the economic benefits from the project are higher than the economic costs.

11.1.14 Sensitivity and Risk Analysis

Usually a project is modelled based on several assumptions. When these assumptions change the results and the performance of such a project is bound to change; sometimes becoming unviable. Sensitivity analysis allows the determination of the 'critical' variables or parameters of the model. Such variables are those whose variations, positive or negative, have the greatest impact on a project's financial and/or economic performance. The analysis is carried out by varying one element at a time and determining the effect of that change on IRR or NPV.

In the current study, the model was tested for sensitivity based on the financial and economic values of the following variables:

- A 20% increase in the investment costs;
- A 20% decrease in the expected project incremental revenues; and
- A 20% increase in projected operation and maintenance costs

Results for the sensitivity analysis are presented in **Table 33**. The results show that although increasing investment costs, increasing O&M costs and decreasing project revenues each by 20% will result to a decrease in the levels of the performance indicators, the changes will not be adverse to the viability of the project.

Table 33: Financial sensitivity

FINANCIAL	COC= 12%		
Scenario	FNPV	FIRR	BCR
Base Case	1,789,862,458	16.1%	1.34
20% increase in Investment Costs	804,394,117	13.6%	1.13
20% Reduction in Project Revenues	238,154,836	12.6%	1.05
20% Increase in O&M Costs	1,728,213,710	16.0%	1.33

Table 34: Economic sensitivity

ECONOMIC	COC= 12%		
Scenario	FNPV	FIRR	BCR
Base Case	1,290,009,791	15.66%	1.31
20% increase in Investment costs	507,131,728	13.25%	1.10
20% Reduction in Project revenues	82,646,792	12.25%	1.02
20% Increase in O&M costs	1,237,608,356	15.51%	1.29

In both financial and economic prices, the projects NPV, IRR and BCR remains positive, higher than 12% and greater than 1 respectively. This implies that the project is not sensitive to at least up to 20% changes in the tested parameters.

Regardless of the insensitivity of the project, the project is prone to some risks such as flooding which can destroy the irrigation infrastructure. Major crop infestation by pests and diseases, political instability, poor management and marketing challenges are the other possible sources of risk. The current design however, considers construction of a flood control dyke to reduce the risk of infrastructural damage. Proper management of crop, training and capacity management better use of pesticides and research on pest and disease resistant varieties are some of the proposed activities under component 2 to control risks of pests and diseases. Component 2 also advocates for better facilities and support services for post-harvest handling and marketing to avert losses that can be caused by market failure. Component 3 on the other hand is designed to ensure that there will be proper management of the scheme and therefore reduce the risks associated with poor management, leadership and decision making.

11.1.15 Operation, Maintenance and Project Sustainability

In addition to the investment costs, the project will require financial resources for the purposes of operation and maintenance. These costs relate to day to day management need for the scheme, repairs and maintenance of irrigation and drainage infrastructure and components replacement costs where and when necessary and water charges by the Water Resource Management Authority (WRMA).

Currently, rice farmers in the Bunyala irrigation scheme pay Kshs. 4,500 per acre, per season which translates to Kshs. 9,000 per acre per year or Kshs. 22,500 per hectare per year. A previous study on O & M charges for public irrigation schemes revealed that the Bunyala irrigation scheme should actually pay Kshs. 8,590 per acre per season or Kshs. 42,950 per hectare per year. This means that the current charges, which are already high, are highly subsidized by the National Irrigation Board.

With the implementation of the project and replacement of the pump fed system with a gravity fed system, the project operation and maintenance needs are expected to significantly reduce. The projects' operation and maintenance costs are assumed at Kshs. 5,000 per acre per year as guided by similar projects in the region. This would translate to approximately Kshs. 12,500 per hectare per year or Kshs. 7,250 per hectare per season. This is a 44.5% decrease from the current Kshs. 22,500 per hectare per year.

It is envisioned that the project beneficiaries will have no challenges raising this amount since the average expected revenue per hectare per year have been approximated to be more than Kshs. 317,300. Assuming that about 40% of this value will be retained for consumption in the household, the average gross revenue from a hectare of irrigated land will be Kshs. 190,650. Since land holding is on average 1.92 ha, an average farm household is expected to earn approximately Kshs. 366,000 per annum out of which the operation and maintenance charges will be approximately Kshs.14, 000.

A project is financially sustainable when it does not incur the risk of running out of cash in the future. Sustainability occurs if the net flow of cumulated generated cash flow is positive for all the years considered.¹⁶ In the current analyses, the project yields positive net cash flows for all the years except for the first four years during which the project is being implemented. Further, gross incomes for the project beneficiaries are shown as sufficient to meet the operation and maintenance costs. This suggests that the project will be financially sustainable.

11.1.16 Conclusions and Recommendations

Implementation of the proposed Lower Nzoia Irrigation Scheme Phase 1 is expected to bring approximately 4,043 ha of land under irrigation and benefit more than 2,100 small scale farmers through improved production of food and provision of incomes. In addition to irrigation infrastructure, the project will benefit from support in post-harvest handling and marketing infrastructure and support for management investments which are covered under components 2 and 3 of the project respectively. The project's incremental benefits are expected to be more than Kshs 1. Billion once production stabilizes. The project is however, expected to cost more than Kshs. 4.4 Billion. Financially, the project is found to be viable resulting to acceptable discount rates and positive cash flows that will guarantee its sustainability. Further, expected household incomes are enough for the farmers to contribute towards operation and maintenance costs further guaranteeing sustainability.

Economically, the project would result to positive externalities in the country as economic benefits are more than the economic costs of the project. Additionally, the provision of food to the country, creation of employment opportunities and generation of foreign exchange from tradable commodities will positively contribute towards the country's gross domestic product GDP and Balance of Payments (BOP). Compared to these benefits, the major negative externality relate to the potential pollution of the soil and water resources following use of agrochemicals and the alteration of natural flora

¹⁶ Guide to Cost Benefit Analysis of Investment Projects;

National Irrigation Board

and fauna as a result of farming activities. However, a sound social and environmental management plan has been developed against these negative externalities.

12 EMERGENCY RESPONSE PLAN

Emergency preparedness is aimed at minimizing the loss of life and property during a natural event. Preparedness includes actions taken in anticipation of the event and special activities both during and immediately after the event.

Two levels of emergency preparedness are identified:

1. Public safety information and
2. Hazard awareness planning.

Three types of emergencies/hazards are envisaged in this ERP

1. Flooding
2. Domestic water contamination
3. Water Borne Diseases Outbreak

Budalangi is a flood prone area and as such the stakeholders have developed Emergency Response Plan as well as Early Warning System to prevent damages caused by flood waters. This plan adopts the existing Early Warning System to build to the Emergency Response Plan in case of any incidents and accidents emanating from the Lower Nzoia Irrigation Project.

12.1 EARLY WARNING SYSTEM

First, the area has a community radio station that addresses issues of floods. This station will be used to create awareness in case of any emergency from the project.

12.2 ROLES AND RESPONSIBILITIES

Coordination is most difficult during the early phase of an emergency. In sudden on-set emergency situations, the Government will normally take the lead role, with the Kenya Red Cross Society playing a crucial role in hands-on efforts. Other players may come on board, usually with material and commodity assistance and where possible with personnel expertise.

In Kenya, disaster preparedness and emergency response are managed at the Office of the President (OOP) under National Disaster Operations Centre.

1. The National (Disaster) Operations Centre (NOC) acts as an information base for receiving reports on all disaster-oriented incidents from different part of the country. Issues a daily situation report, and maintains a 24-hour communication lines with all areas. This the core centre for disaster management
2. The Ministry of Public Health and Sanitation will have the responsibility of health related emergencies including outbreak of diseases and contamination of domestic water sources.
3. For flooding the Ministry of Special Programmes will coordinate provision of emergency survival kits including shelter, drinking water among others. It should be noted that in many incidents, Red Cross personnel have always been the first to respond in emergency cases. The area Red Cross coordinator contacts should be identified to enable speedy response.
4. The Kenya Red Cross Society is constitutionally mandated with the responsibility of assisting the Kenyan Government carry out humanitarian work

in times of peace or conflict. Natural disasters such as drought, famine, floods. Kenya Red Cross Disaster Preparedness has a regional office in the area which can provide human and material.

12.3 EVACUATION PLAN

The evacuation plan is for the case of flooding in the project area. As described in the project area description, the project area is a floodplain. In case of flooding in the area, the plan is to move the people from the area to higher grounds. In the project area, a social hall has been used for sheltering those displaced by floods. This hall constructed by Constituency Development Funds (CDF) will be used in case of flood displacement.

12.4 WATER CONTAMINATION

Drinking water is a serious problem for the stricken population in the aftermath of many natural disasters. Potable water in jerry cans should be arranged if required. The minimum amount of water needed to survive is 5 liters per person per day. Total lack of water leads to dehydration and death. Especially babies are vulnerable. The temporary abnormal living conditions, water-logging in ponds by storm-surges, present pollution risks. It is for health reasons necessary to maintain the hygiene levels of the stricken population from the very beginning.

Water purifying tablets with instructions on how to use should be considered. Chemical disinfections as a method of water treatment on a large scale is recommended only when storage and/or filtration cannot meet the needs. It will then be required to purify wells, sand filters, pumps, and piped water systems. Various forms of chlorine can be used, as it is widely used, cheaper and often readily available. The most generally suitable form of chlorine in cases of emergencies is calcium hypochlorite powder.

Boiling is the surest and perhaps the simplest method of water sterilization. If fuel supply (fire wood) is available families should be encouraged to do so, until safe water supply is established.

If you have a large number of people assembled for a long time, sanitation could be a problem. Diseases can easily spread. Deep trench latrines, separately for men and women must be considered if none are available or existing ones are destroyed or flooded. These should be constructed at least six metres from dwellings and 30 to 50 metres from water sources. You will need 1 latrine per 100 people.

Many types of emergencies could occur including floods, disease outbreaks, and accidents. The envisaged ones are tabulated below, detailing the consequences and the relevant manpower expertise. The effects and resultant relief as well as the manpower needs are however, cross cutting.

The following matrix is drawn as the emergency response matrix on local level in regard to responsibilities, emergency and remedy that may be achieved in an emergency situation.

Table 2: Emergency Response Plan Matrix

Emergency	Objective	Response	Agency responsible
Water contamination and sanitation	Users are involved in the management and maintenance of hygiene facilities	Ensure that systems/ personnel for identification of key hygiene risks of public health importance are in place	Min. of Public Health & Sanitation(MOPH)
		Ensure an effective mechanism for representative and participatory input from all users of hygiene facilities, including in the initial design	Ministry of Water (MOW&I) Min. of Public Health & Sanitation(MOPH), Provincial Representatives, affected population representatives,
		Ensure existence of systems for provision of equitable access to the resources or facilities needed to continue or achieve promoted hygiene practices.	Min. of Public Health & Sanitation(MOPH), MSSP, PA&IS, Lead Agency,
		Ensure relevant ministries implement hygiene promotion messages and activities that address key behaviours and misconceptions.	Min. of Public Health & Sanitation(MOPH)
		Ensure Involvement of representatives from affected population to participate in planning, training, implementation, monitoring and evaluation of hygiene programmes	PA&IS
Adequate water supply exists	Public water points are sufficiently close to households.	Ensure all households are within 500 metres of the nearest water point where applicable	MOW&I
	All people have safe and equitable access to a sufficient quantity of water for drinking, cooking and personal and domestic hygiene.	Ensure average water use for drinking, cooking and personal hygiene in any household is at least 15 litres per person per day	
		Ensure limited queuing time at a water source to no more than 15 minutes where applicable	

National Irrigation Board

Emergency	Objective	Response	Agency responsible
		Ensure the fill time for a 20-litre container is no more than three minutes where applicable	
		Ensure that relevant departments provide water sources and systems such that appropriate quantities of water are available consistently or on a regular basis	
	Water is palatable, potable and safe for personal and domestic hygiene.	Conduct sanitary survey for faecal contamination	MOW&I MOPH&S
		Ensure the provision of water with faecal coli forms per 100ml at the point of delivery as appropriate	
		Ensure the promotion of protected or treated water sources over other readily available water sources	
		Ensure that post-delivery water contamination is Minimized	
		Treat water supplies with a disinfectant	
		Treat all water supplies at times of risk or presence of diarrhoea epidemic with a disinfectant so that there is a free chlorine residual at the tap of 0.5mg per litre and turbidity is below 5 NTU	
	Affected people can safely and sufficiently collect, store and use water for drinking, cooking and personal hygiene.	Provide each household with at least two clean water collecting containers of 10-20 litres as appropriate	
		Provide each household with enough clean water storage containers to ensure there is always water in the household	
		Provide water collection and storage containers with narrow necks and/or	

National Irrigation Board

Emergency	Objective	Response	Agency responsible
		covers, or other safe means of storage, drawing and handling.	
		Provide at least 250g of soap available for personal hygiene per person per month.	
		Provide sufficient bathing cubicles or separate cubicles for men and women where communal bathing facilities are necessary.	
Excreta is disposed off	People have adequate, safe, close and rapidly accessible toilets.	Limit toilet use to a maximum of 20 people/toilet	MOPH&S Lead agency, PA&IS
		Arrange toilet use by household(s) and/or by sex	MOPH&S Lead agency, PA&IS
		Separate toilets for women and men in public places (markets, distribution centres, health centres, etc.)	MOPH&S Lead agency, PA&IS
		Clean and maintain shared or public toilets in such a way that they are used by all intended users	Affected population, Lead agency, PA&IS
		Limit number of toilets in camp settings according to recommended standards	
		Ensure all dwellings are no more than 50 metres from toilets	MOPH&S
		Promote hygienic toilet use.	
		Dispose of children's faeces immediately and hygienically	Affected population, Lead agency, PA&IS
Toilets are sited, designed, constructed and maintained such that they are comfortable, hygienic and safe to use.	Consult and get approval from users (especially women) on the siting and design of the toilet	Lead agency, MOPH&S, Affected population	
	Design build and locate toilets with the following features: – can be used by all sections of the population	Lead agency, MOPH&S, Affected population PA&IS	

Emergency	Objective	Response	Agency responsible
		<ul style="list-style-type: none"> – sited to minimize threats to users, especially women and girls, throughout the day and night; – easy to keep clean and do not present a health hazard; – provide privacy in line with the norms of the users; – allow for the disposal of women’s sanitary protection, or provide women with the necessary privacy for washing and drying sanitary protection cloths; -- minimize fly and mosquito breeding 	
		Construct toilets with hygienic seal.	MOPH&S
		Construct toilets that have an adequate and regular supply of water	
		Build pit latrines and soak ways to the following criteria: 30 metres from any groundwater source, bottom of any latrine is at least 1.5 metres above the water table. Drainage or spillage from defecation systems must not run away from any surface water source or shallow groundwater source	
		Promote hand washing after defecation and before eating and food preparation	
		Provide people with tools and materials for constructing, maintaining and cleaning their own toilets if appropriate	Lead agency, MOPH&S
Vectors are controlled	Affected people protect themselves from vectors that represent a significant risk to health or	Educate populations at risk from vector-borne disease understand the modes of transmission and possible methods of prevention	MOPH&S
		Provide access to shelters that do not harbour or encourage the growth of	Lead agency, MSSP

National Irrigation Board

Emergency	Objective	Response	Agency responsible
	wellbeing.	vector populations and are protected by appropriate vector control measures.	
		Promote the avoidance of exposure to mosquitoes during peak biting times. Pay Special attention to protection of high-risk groups such as pregnant and feeding mothers, babies, infants, older people and the sick	MOPH&S
		Educate users in the effective use of treated mosquito nets.	
		Control human body lice where louse-borne typhus or relapsing fever is a threat	MOPH&S, Affected population
		Air and wash Bedding and clothing regularly	Affected population
		Protect Food from contamination by vectors such as flies, insects and rodents.	NCPB Lead agency Affected population
Disease and nuisance vectors are kept to an acceptable level.		Ensure that displaced populations are in locations that minimize their exposure to mosquitoes	MOPH&S Lead agency
		Destroy vector breeding and resting sites	
		Carry out intensive fly control high density settlements when there is a risk or the presence of a diarrhoea epidemic.	
		Keep the population density of mosquitoes low to avoid the risk of excessive transmission levels and infection	
		Diagnose people infected with malaria early	
		Give treatment to People infected with malaria early	

National Irrigation Board

Emergency	Objective	Response	Agency responsible
	Chemical vector control measures are carried out in a safe and environmentally sound manner that avoids creating resistance to the substances used.	<p>Ensure protection of staff and affected persons by providing training.</p> <p>Ensure protection of staff and affected persons by providing protective clothing.</p> <p>Ensure protection of staff and affected persons by providing bathing facilities.</p> <p>Ensure protection of staff and affected persons by providing supervision.</p> <p>Ensure protection of staff and affected persons by restricting the number of hours spent handling chemicals.</p> <p>Ensure the choice, quality, transport and storage of chemicals used for vector control, the application equipment and the disposal of the substances.</p> <p>Ensure that affected persons and communities are informed about the potential risks of the substances used in chemical vector control and about the schedule for application.</p> <p>Ensure that affected persons and communities are protected during and after the application of poisons or pesticides, according to internationally agreed upon procedures</p>	<p>MOPH&S Lead agency</p> <p>Lead agency Provincial/ District rep Affected Population rep</p> <p>MOPH&S Lead agency Provincial/ District rep Affected Population rep</p>
Solid waste is managed	Solid wastes (including medical wastes) are collected and disposed of safely.	<p>Ensure involvement of people from the affected population in the design and implementation of the solid waste programme.</p> <p>Ensure that waste is burned or buried in a specified refuse pit or put household waste in containers daily for regular collection.</p> <p>Ensure that households are provided with access to a refuse container or a communal refuse pit that is no more than 100 metres away.</p> <p>Where domestic refuse is not buried on-site, ensure the provision of at least one 100-litre refuse container per every 10 families.</p>	MOPH&S Lead agency Affected population

National Irrigation Board

Emergency	Objective	Response	Agency responsible
		Ensure the removal of refuse from the settlement before it becomes a nuisance or a health risk	Lead agency Affected population
		Ensure that medical wastes is separated and disposed of separately	MOPH&S Lead agency
		Provide either a correctly designed, constructed, and operated pit or an incinerator with a deep ash pit within the boundaries of each health facility	MOPH&S Lead agency Affected population
		Ensure that contaminated or dangerous medical wastes (needles, glass, dressings, drugs, etc.) are kept out of living areas and public spaces at all times	MOPH&S Lead agency Affected population
		Ensure that refuse pits, bins, and/or specified areas at public places, such as markets and slaughtering areas, are clearly marked and appropriately fenced	MOPH&S Lead agency Affected population
		Ensure a regular collection system for emptying refuse pits, bins, and/or specified areas in public places is maintained	
		Ensure that final disposal of solid waste in such a place and in such a way as to avoid creating health and environmental problems for the local and affected populations.	
Adequate drainage exists	Adequate drainage to prevent erosion and standing water is provided	Ensure that areas around dwellings and water points kept free of standing wastewater	
		Ensure storm waters drains are Kept clear	
		Ensure the prevention of floods and erosion in shelters, paths, and water and sanitation facilities	
		Ensure water point drainage is planned. (This includes drainage from washing and bathing areas as well as water collection points)	
		Ensure the construction of water point drainage. (This includes drainage from washing and bathing areas as well as water collection points)	

National Irrigation Board

Emergency	Objective	Response	Agency responsible
		Ensure the maintenance of water point drainage. (This includes drainage from washing and bathing areas as well as water collection points)	
		Ensure that drainage waters is prevented from polluting existing surface or groundwater sources	
		Ensure that drainage waters is prevent from causing erosion	
		Where necessary, ensure provision of sufficient numbers of appropriate tools for small drainage works and maintenance	

13 PUBLIC CONSULTATION

Public consultation and disclosure of information about Lower Nzoia Irrigation Scheme Project took place through household surveys and focused group meetings. The public consultation exercise was conducted during the month of March to April 2012 in the project area. During the scoping process, a stakeholder mapping exercise was undertaken to identify Interested and Affected Parties (I&AP) to the project. The mapping exercise was conducted simultaneously with the scoping exercise. The exercise identified all the stakeholders of the project within the area including the communities around the area, administration, government ministries and agencies and private sector among other stakeholders.

13.1 STAKEHOLDER MAPPING

At the start of the process, stakeholders were grouped based on the following categories:-

- Relevant Bunyala and Siaya District governmental offices including District Agricultural Office, Public Health Office, District Gender and Social Development Office, District Children's Office, MoH, MoW&I, MoE, OOP, MoA among others
- Government Agencies including NEMA, NIB, WRMA,
- Various Cooperative/ Association
- Local community or the project beneficiaries (farmers)

13.2 STAKEHOLDER IDENTIFICATION

The first step in the process of public participation process was stakeholder identification, determining the project stakeholders, their key groupings. Stakeholder identification was to determine all organizations and individuals who may be directly or indirectly (positively or negatively) affected by the Lower Nzoia Irrigation Development Scheme.

To identify the stakeholders of this project, a list of relevant ministries and departments of the government was compiled based on the government structures. The list of persons and institutions contacted and consulted is appended on this report.

13.3 STAKEHOLDER CONSULTATION

Stakeholder consultation was in form of interviews, focus group meetings and Participatory Rural Appraisal (PRA) in and around Lower Nzoia Irrigation Scheme Development.

13.3.1 Focus Group Meetings

Focus Group Meetings were held in following sections of the scheme;

- Sumba
- Nyadorera A
- Nyadorera B
- Umala
- Nzoia Market

The stakeholders included NIB representatives and project beneficiaries—farmers. The proceedings of the workshop and stakeholder consultation are captured and integrated in this report.

13.4 ISSUES AND CONCERNS

All issues, comments, suggestions and information contributed by stakeholders either by way of focus group meetings or informal meetings are compiled into an Issues Report. The report is categorized in different disciplines. The issues raised during the consultation process are highlighted in **annex B**.

14 RECOMMENDATIONS AND CONCLUSION

14.1 RECOMMENDATIONS

There is a need for NIB to establish a PMU with a wide representation from the relevant line ministries as identified in this study. The PMU should have representation from the implementing agency (NIB) which will serve as the secretariat, Ministry of Health to advice on management of health impacts, WRMA to advice on water resources, Ministry of Agriculture to provide advice on IPM among other relevant stakeholders.

The project beneficiaries (IWUAs) should be trained in good farming husbandry and pest management especially in the area of Integrated Pest Management (IPM).

A refresher training program should be introduced throughout the whole scheme and extension farms on the adequate application of fertilizer use per hectare of land and during what conditions should it be undertaken throughout the project. The types and amounts of pesticides should also be part of this training. This training should be a hands-on approach that can be introduced at farmer's field schools (FFS).

To prevent against water-logging in the scheme farms, the farmers should be trained in efficient irrigation water management.

At the project level, Ministry of Water and Irrigation through NIB should be equipped to have the capacity to undertake sample analysis of parameters identified in the monitoring plan. These should include soil and water quality analysis. The project staff should also be trained in monitoring of the identified impacts to enable them monitor the project performance.

Ministry of Environment and NEMA should be equipped with technical and institutional capacity in the field of wetland management. NEMA needs to develop sector specific guidelines that will provide environmental guidelines for the development of the agricultural sector. NEMA's capacity in monitoring of environmental indicators should also be strengthened to effectively monitor parameters.

At the district level, the environment officers should be trained and the department strengthened to work closely with NEMA. The training should cover environmental assessment, monitoring and review of assessments and management plans.

The civil works construction firm should use the local communities labour to construct, rehabilitate the scheme's canals, unit and line gates. This way, community members will learn to operate and maintain the infrastructure.

The capacity of project proponent (NIB) should be built to enable the office to be able to mitigate and monitor the impacts. The areas that require capacity building include;

1. Technical staff at the project level which should include community liaison officer.
2. A budget for extension services

3. Logistical support for other stakeholders identified in the ESMP that will have their input in the implementation of the plan.

Capacity building should be financed through the NMR project sub-component on strengthening the capacity of the Water Resources Management.

NIB should also establish project office in Bunyala that will have a community liaison officer to respond to community issues as they arise and be the bridge between the relevant government agencies that are responsible for the environmental and social management plan.

It is advisable that before the project commencement, there is agent need to rehabilitate the existing dyke or building of a new dyke that will be necessary to protect the propose project infrastructure from floods.

To prevent water stagnation, the designers should ensure the canals gradient is enhanced to increase water flow. Moreover the main canal should have emergency spillways.

Discharge from the irrigation farms should pass through a wetland to enable filtration of agrochemicals washed from the farms. For the southern drainage, discharging into Yala swamp will ensure that the swamp filters the chemicals. For the right drainage, discharging spent irrigation water into Nzoia River without filtering will create eutrophication environment into Lake Victoria. In this regard, the project will create an artificial wetland in areas where there is discharge into Nzoia River. To avoid flooding upstream of Nzoia River, the weir should have overflow spillway.

14.2 CONCLUSION

The management of water application systems as well as the suitability of related agronomic practices has a dramatic influence on the environmental impact of irrigated agriculture. Constraints in the water delivery systems (e.g., continuous versus on-demand water supply), extremely low water quality of the irrigation water supply, and limitations to investment on improved technologies exacerbate the environmental damage derived from irrigation and limit the options available to farmers for mitigating the problem. Nevertheless, improved management and technologies are the main tools available to ensure the sustainability and productivity of irrigation in Nzoia Scheme and its extension farms.

The general problems that affect irrigated areas are water-logging, salinization, soil erosion, downstream degradation of water quality by salts, agro-chemicals and toxic leachates. All these are a serious environmental problem.

In Nzoia Irrigation Scheme, the main attributes associated with poor irrigation outputs are due to high salinity levels, water loss, water logging, run-off from agricultural chemicals and soil erosion. Other related impacts are contamination of groundwater sources and human related impacts such as public health impacts caused by water-borne diseases-- malaria, cholera, typhoid and amoebiasis.

Water-logging and salinization impacts can be reduced by investments in education and management capacities, drainage improvements and soil stability works are relevant for the case of Nzoia Irrigation Scheme and its extension farms.

The impact of agricultural run-off on water quality is not well documented in Kenya and as result data on water pollution is limited or non-existent. Furthermore, available data is mostly aggregated, not distinguishing the relative proportion of point and non-point sources. Therefore, the water quality databases found are often of little value in pollution management at the river basin scale, and are not useful in determining the impacts of specific agricultural practices (irrigation) in relation to other types of anthropogenic impacts.

Public health impacts in irrigation practices are mainly associated with polluted water as the major cause of water borne diseases. Surface runoff, stagnant waters and improperly designed rural sanitary facilities contribute to this problem. The use of untreated (or poorly treated) human wastewater throughout Nzoia Irrigation Scheme contributes to direct contamination of food produce such as vegetables. Furthermore, in Nzoia and its immediate environs there is little or no treatment of municipal sewage resulting in direct sewage wastewater flows into River Nzoia and its tributaries. To solve such issues education on the use of proper sanitary facilities and adequate waste water treatment facilities upriver have to be introduced to alleviate the health related problems associated with irrigation water.

Finally, agriculture development has to go on to feed the population that keeps on growing while maintaining the natural resource base that supports agronomy. There is need to balance between human activities and the resource base.

ANNEXES

A LIST OF PARTICIPANTS

LIST OF PARTICIPANTS IN THE WORKSHOP ON 15TH APRIL 2010 FOR LOWER NZOIA IRRIGATION DEVELOPMENT PROJECT. Held on 12th April 2010 at MauMau Market				
Sub -Location : Mabinju; Lugare; Rugunga				
Location: South West Alego				
District : Siaya				
Provincial Administration Representative :				
Serial No.	Name of Attendants/Institution	Contact person/Designation	Address & Telephone	ID Number
1	Bernard Ochieng Omenda	A.G Chief Khajula	0726 613617	
2	John Kudombi	A/ Chief Khajula	0723 133557	915049
3	Boniface Oduori	Opinion leader		3422880
4	Alexander N. Namuye	Community Member	0712 995602	
5	Paul Agunda	Rugunga Luguru		42211955
6	Michael O.Bubolu	Mabinju Luguru	0726 739656	
7	Linus A.Buluma	ODM sub-loc V.C	0731 219969	8373542
8	Atonus Charles	Community Member		
9	Lenard Arodi	Community Member	0715 061933	27439977
10	Linus Mayamba	Community Member	0710 6295666	

National Irrigation Board

11	Pastor Pascal Odongo	Pastor Baptist	0710 907630	14603231
12	James Odero	Community Member	0723 191512	91502340
13	Eric Were Mukudi	Community Member	0714 503391	21487899
14	Agnes owuru	Community Member		
15	Jacinta Awino	Community Member		
16	Josphine Achola	Community Member		
17	Irene Night	Community Member		
18	Rose Magusi	Community Member		
19	Rosemary Richard	Community Member		
20	Florance C. Achoka	Community Member	0718 402586	7897123
21	Janephe Jura	Community Member	0729 462768	9104158
22	Grace Anyango	Community Member		
23	Carolyne Juma	Community Member	0726 484808	9104158
24	Lilian Were	Community Member		
25	Bento Conny	Community Member		
26	Tabu Ogesse	Community Member	0723 845246	
27	Andrew Wafula	Community Member		
28	Patrick Juma Were	Community Member	0725 982 427	0729 568660
29	Evans Musumba	Community Member		

National Irrigation Board

30	Sylvester Mango Wandera	Community Member	0710 122406	20099917
31	Alfred Ogana	Community Member		
32	Julius Aol	Community Member		
33	Simon Ojiambo	Community Member	0718 8881968	281800869
34	Peter Khayombe	Community Member		2275134
35	Ebrahim Bwire	Community Member	0718 402589	
36	Benard Ojiambo	Community Member		
37	Richard Khasena	Community Member	0712 355966	1727736
38	Barbnabas Oniala	Community Member		
39	Fidelis Onyere	Community Member		23962383
40	Evans Ouma	Community Member		
41	Patrick Buluma	Community Member	0725 995697	3457650
42	Malobi Rapheal	Community Member	0729 852095	
43	Nabomwe Joseph	Community Member	0728 721850	27150807
44	Ibrahim Okumu	Community Member	0724 320572	22338511
45	Paul Wangira	Community Member	0722 369528	
46	William Osuri	Pastor	0736 860894	4211108
47	Fredrick Bwire	Community Member	0716 079093	
48	John B.Musumba	Community Member	0715 854641	8028788

National Irrigation Board

49	Josphat Okumu	Community Member		
50	Dickson Okello	Community Member	0720 112670	
51	Washington Mayamba	Community Member		
52	Thomas Owang	Community Member		
53	Mathers Makhuku	Community Member	0728 790056	8617742
54	Patnul O. Otieno	Community Member	0720 084394	26045915
55	Denis Asabu Dibo	Community Member	0713 879105	
56	Odwory Joseph	Community Member	0716 059335	
57	George S. Mangeni	Community Member	0719 861635	1170908
58	Alfred Agoya	Community Member		
59	James M. Olande	Community Member	0729 0911432	22928885
60	Benard O. Odhiambo	Community Member		
61	Joseph Mukhere	Community Member		10121782
62	Fred Maloba	Community Member		
63	Francis Ojiambo	Community Member		
64	Baloy Okuo	Community Member		
65	Jonah fredrick	Community Member	0727 641537	25799196
66	Geofrey Siguda	Community Member		
67	Margare Ogaita	Community Member		

National Irrigation Board

68	Margarte Achieng	Community Member			
69	Angeline Bwire	Community Member			
70	Cosiolata Oyweri	Community Member			
71	Onsoro Ogutu	Community Member			
72	Nancklete Nanga`na	Community Member			
73	Tomas s.Songa	Mabinju Luguru			
74	Emmanuel Dibo	Community Member			
75	Kallavi Shiundu	Community Member			
76	Okello Owang	Community Member			
77	Salima Rajab	Community Member			
78	Julius Obago	Community Member			
79	James Wafwafwa	Community Member			
80	Duncan Okello	Community Member			
81	James Obwwori	Community Member			
82	Electrine Nabwire	Community Member			
83	Tonny Nangaga	Community Member			
84	James Nadebu	Community Member			
85	Katunaga Buyanja	Community Member			
86	Almerida Obwori	Community Member			

National Irrigation Board

87	Charles	Community Member	0718 402539		
88	Rose Mukere	Community Member			
89	Pius Ndege	Community Member			
90	Gentrix Sumba	Community Member	0710 239359		
91	Mark Ouma	Community Member			
92	Dickson Okumu	Community Member			
93	Bendickt Obingo	Community Member			
94	James Okello	Community Member			
95	cathrine Andiaga	Community Member			
96	Dennis wandati	Community Member			
97	Michael Odawula	Community Member			
98	Peter Wanyama	Community Member			
99	Franco Otieno	Community Member			
100	Peter Anyande	Community Member			
101	Benson Juma	Community Member			
102	Samuwl Otero	Community Member			
103	Samson Ebuye	Community Member			
104	Jared Juma	Community Member			
105	Christppher Bilo	Community Member			

National Irrigation Board

106	Topher Okello	Community Member		
107	Anjeline Opiyo	Community Member		
108	Felister Were	Community Member		
109	Jane Tabu	Community Member		
110	Tobias Fred	Community Member		
111	Toma Bwire	Community Member		
112	Fred Owuma	Community Member		
113	Paul Mango	Community Member		
		Witnessed : Nyawira -NIB Social Development Specialist 0722 391456		
LIST OF WORKSHOP ON 15TH APRIL 2010 FOR LOWER NZOIA IRRIGATION DEVELOPMENT PROJECT. CONTRACT NO.NIB/T/07/2009-2010				
Sub -Location : KALKADA URADI;KOMENYA/KALAKA; KOMENYA/KOWALA				
Location:				
District :				
Provincial Administration Representative : Held at Rabar Hospital 14th April 2010				
Serial No.	Name of Attendants/Institution	Contact person/Designation	Address & Telephone	ID Number
1	Vitalis A. Ongori	Community Member	0722 753512	0 96019
2	G.P Omony	Community Member	0710 355990	3327285

National Irrigation Board

3	Thomas Opondo	Community Member	0720 768796	112711679
4	Modestrus Okoth Odhiambo	Community Member	0717 055210	11196476
5	William Otieno Ogutu	Community Member	0720 247242	9644732
6	Charles Lambogo	Community Member	0717 055210	
7	Dick Otieno Wanga	Community Member	0721 343 232	1238550
8	Patricia A. Ogola	Community Member	0726 904676	11549014
9	Morris Sewe	Community Member	0721 536757	8781387
10	Jahanes Osono	Community Member		
11	Rev. David Onyango Wadhala	Community Member	0722 815146	6947118
12	C. Ohito Okello	Community Member		3437924
13	Okello Ondongo	Community Member		
14	Paul Agunda	Community Member		18585095
15	Jones TAB	Community Member		
16	Hagond	Community Member		16011524
17	Fitalis Oluoch	Community Member	0716 821039	5301137
18	George Omollo	Community Member		
19	Samuel Agunda	Community Member		
20	Charles Owino Gombe	Community Member		4870341
21	Godwin Otieno Opiyo	Community Member	0726 245802	13682157

National Irrigation Board

22	Ann Akongo	Community Member		
23	Alice Okonyo	Community Member		
24	Clementina Ahowa	Community Member		
25	Teresa Awour	Community Member		
26	Philista Otieno	Community Member		
27	Elias Oyogi Olute	Community Member	0728 736716	1898078
28	Vitalis Okumu Omburu	Community Member	057 5201619	2631540
29	Marcus Ochieng Owina	Community Member	0710 820349	0 360806
30	Grace Otieno	Community Member		
31	Nelly C.A.Onyango	Community Member	0728 135420	21535549
32	Risper A. Sindala	Community Member	0716 328904	4874270
33	Otieno Oyoge	Community Member		284728
34	Thomas mangaa	Community Member		
35	Andrew Msleya	Community Member	0720 57815 9286651	
		YES=35		
		NO=0		
		UNDECIDED=0		
		Witnessed by Nyawira NIB Social Development Specialist		

LIST OF PARTICIPANTS WORKSHOP ON 15TH APRIL 2010 FOR LOWER NZOIA IRRIGATION DEVELOPMENT PROJECT . CONTRACT NO.NIB/T/07/2009-2010				
Sub -Location : BUNYALA EAST; BUNYALA WEST;BUNYALA CENTRAL				
Location: BUNYALA CENTRAL				
District : BUNYALA				
Provincial Administration Representative : Held at Mubwayo A/Chief's Office (compound) on 12th April 10				
Serial No.	Name of Attendants/Institution	Contact person/Designation	Address & Telephone	ID Number
1	Patrick Mwanda	Ass chief M.East	0713 138181	8026751
2	Alex Ogeye	Ass chief M.West		
3	Boniface Dauwa	Community Member	0725 525788	20486610
4	Fidelis Omina	Community Member		5683213
5	Richard Kundu	Community Member		11344002
6	Boniface Asembo	Community Member		
7	Silvia Ouma	Community Member	0722 999764	21938681
8	Samwel Opondo	Community Member		
9	Pascal Were	Community Member		4645441
10	JaneRose Okwiri	Community Member		80267274
11	Jane Magoya	Community Member		
12	Anna Naka	Community Member		

National Irrigation Board

13	Philis Akumu	Community Member		
14	Madgaline Majuma	Community Member		
15	Jenifa Ogaya	Community Member		
16	Alphonce Wanyama	Community Member		
17	HELLEN Akello	Community Member		
18	Resula Abuori	Community Member		
19	Joseph FDHALI	Community Member	0710 9745521	
20	Grado Otiato	Community Member		
21	Bathlomew	Community Member		
22	James Andera	Community Member		
23	Christpher Okumu	Community Member		
24	Cyril Jwende	Community Member		
25	Ogoba Godfren	Community Member		
26	Alfred Mayumba	Community Member		
27	Okumu chrispanus	Community Member		
28	Makonde Juma	Community Member		
29	Thomas Ahenda	Community Member		
30	Anthony Afubwa	Community Member		
31	John Namuye	Community Member		

National Irrigation Board

32	Michael Wangoma	Community Member		
33	Sabastian Otoro	Community Member		
34	Greogory Abara	Community Member		
35	Nicholas Ombero	Community Member		
36	Benjamin Okoba	Community Member		
37	Cornel Acholla	Community Member		
38	Apwoti Mbalabasi	Community Member		
39	Gladys Alwanga	Community Member		
40	Ibrahim Songa	Community Member		
41	Hjohn Juma	Community Member		
42	Magret Anyango	Community Member		
43	Nixon Musolo	Community Member		
44	Dismas Agomba	Community Member		
45	Benjamin Iwenge	Community Member		
46	Nambirwa Joseph	Community Member		
47	Madede Disckson	Community Member		
48	Alex Nakhuwanda	Community Member		
49	Pascal Lugendo	Community Member		
50	Odundo Thomas	Community Member		

National Irrigation Board

51	Michael Abiba	Community Member		
52	Kevin Ojiambo	Community Member		
53	Magret Oula	Community Member		
54	Otini Nicholas	Community Member		
55	Raphael Omoga	Community Member		
56	John Khabiri	Community Member		
57	Bonface Edali	Community Member		
58	Paul Onyango	Community Member		
59	Clementina Ongamo	Community Member		
60	Jacinta Sara	Community Member		
61	Rosemary Lugendo	Community Member		
62	Dominic Odhiambo	Community Member		
63	Michael Katebe	Community Member	0728 591961	672684
64	John D. Weke	Community Member		
65	Charles Ngayo	Community Member		
66	Henry Andera	Community Member		
67	Denis Odouri	Community Member		
68	Odaka Simon	Community Member		
69	John Oduori	Community Member		

National Irrigation Board

70	Peter Odouri	Community Member		
71	Isaac Odouri	Community Member		
72	Makhuri Ogogo	Community Member		
73	Wanyama Jackson	Community Member		
74	John Majoni	Community Member		
75	Douglas Olanda	Community Member		
76	Olando Michael	Community Member		
77	Kilo Moses	Community Member		
78	Ganga Ingeke	Community Member		
79	Jacinta Auma	Community Member		
80	Charles Somi	Community Member		
81	Peter Omieno	Community Member	0710 559259	4210482
82	Ombido Filex	Community Member		
83	Alfred Mbogo	Ass Chief Central		
84	John Namia	Community Member	0721 658803	5683903
85	Susan Maloba	Community Member		
86	Pascal Omodo	Community Member		
87	Okobori Stephen	Community Member		
88	Oscar Andera	Community Member		

89	Pascal Okwiri	Community Member		
90	Anthony Ouma	Community Member		
91	James Ojiambo	Community Member		
92	Odeyo Andrew	Community Member		
93	Peter Kaya	Community Member		
94	John Naule	Community Member		
95	Mathew Ogolla	Community Member		
96	Almerida Nabwire	Community Member		
97	Jacinta Rapando	Community Member		

LIST OF PARTICIPANTS IN THE ASSISTANT CHIEF'S BARAZA FOR ELECTING FARMERS REPRESENTATIVES WORKSHOP ON 15TH APRIL 2010 FOR LOWER NZOIA IRRIGATION DEVELOPMENT PROJECT . CONTRACT NO.NIB/T/07/2009-2010

Sub -Location :SUMBA+ NYADORERA `B`				
Location:				
District :				
Provincial Administration Representative : Held in a Church Near Nyadorera Shopping centre on 13th April 2010				
Serial No.	Name of Attendants/Institution	Contact person/Designation	Address & Telephone	ID Number
1	William Ogola	YOUTH	0722 794394	21402058
2	Zablon Onyango	Community Member	0711 831005	11825370
3	Lucas Odour	Community Member		

National Irrigation Board

4	Wilson Onyango Sawege	Community Member	0735 953151	5989629	
5	Antony Simon Okondo	YOUTH	0723 355510	22630848	
6	Shadrack Bar Okumu	Community Member	0715 627148	1818358	
7	Thomas Okello	Community Member	0734 627055	8259120	
8	Meshadrack Obunde Ayieko	Farmer	0711 872296	190503	
9	Wilfridah Adhiambo	Community Member		506652	
10	Dalmas Sikuku	Community Member		2878774	
11	Vitalis Omondi	Farmer	0729 576 370	8738456	
12	Arura Ochieng	Community Member		8258461	
13	Thomas M.Okello	Community Member		1186955	
14	James Okumu	Community Member		11438148	
15	Benard Owino	Community Member			
16	Richard Ogolla	Community Member			
17	Clay Madara	Community Member			
18	Stephen Maina	Community Member			
19	Charles Otieno	Community Member			
20	Zablon Onyango	Community Member			
21	Wilfridah Aloo	Community Member			
22	Cathrine Mageko	Community Member			

National Irrigation Board

23	James Okumu	Community Member			
24	Truphena Adhiambo	Community Member			
25	Joseph Odongo	Community Member			
26	Meshak Ayieko	Community Member			
27	Fransisca Owembo	Community Member			
28	Samuel Opaka	Community Member			
29	Anjeline Odhiambo	Community Member			
30	Paulina Okello	Community Member			
31	Benta Omondi	Community Member			
32	Margaret Atieno	Community Member			
33	Jane Anyango	Community Member			
34	Paskalia Omondi	Community Member			
35	Anastasia Lwambe	Community Member			
36	Wangira	Community Member			
37	Wilson Onyango	Community Member			
38	Patric Odhiambo	Community Member			
39	Christoper Otieno	Community Member			
40	Sylvester Dwas	Community Member			
41	Peter Mukupo	Community Member			

National Irrigation Board

42	Samson Ouma	Community Member			
43	George Odhiambo	Community Member			
44	Belinda Akinyi	Community Member			
45	Celine Awour	Community Member			
46	Shadrack Bar	Community Member			
47	Amos Onyango	Community Member			
48	Kennedy Otieno	Community Member			
49	charles Meli	Community Member			
50	Bnejamin Muganda	Community Member			
51	Acholla Koyo	Community Member			
52	Wilson Onyango	Community Member			
53	Thomas Okello	Community Member			
54	Alfred Ooko	Community Member			
55	Nathaniel Kwedende	Community Member			
56	Aeneo Ochieng	Community Member			
57	Pascalina Okudo	Community Member			
58	Alex Omia	Community Member			
59	Vitalis Owuor	Community Member			
60	Zacharia Kabete	Community Member			

National Irrigation Board

61	Janes Okumu	Community Member			
62	Musa Ndagw`	Community Member			
63	John Obilo	Community Member			
64	Nyagweso Oruda	Community Member			
65	George Kanot	Community Member			
66	Brian Wassunna	Community Member			
67	Benjamin Lumutu	Community Member			
68	Andrew Odundo	Community Member			
69	William Owour	Community Member			
70	Joseph Ayeiko	Community Member			
71	Jeremia Ngo`nga`	Community Member			
72	Lorine Oyamo	Community Member			
73	John Okanga	Community Member			
74	Rosemary Odhiambo	Community Member			
75	Margaret Odondo	Community Member			
76	Maria Otieno	Community Member			
77	Joseph Okello	Community Member			
78	Triza Atieno	Community Member			
79	Marita Adhiambo	Community Member			

National Irrigation Board

80	James Munjala	Community Member			
81	Joseph Nyasudi	Community Member			
82	Alex Ouma	Community Member			
83	Patricia Ogola	Community Member			
84	Elizabeth Aneliwo	Community Member			
85	Masella Aoko	Community Member			
86	Ordad Adongo	Community Member			
87	George Wamera	Community Member			
88	Lucas Olielo	Community Member			
89	George Odongo	Community Member			
90	Mathews Okoth	Community Member			
91	Margaret Odour	Community Member			
92	Maeseline Nabwire	Community Member			
93	Ochieng Musa	Community Member			
94	Tereza Odongo	Community Member			
95	Julias Odhiambo	Community Member			
96	Maurine Otieno	Community Member			
97	Lucas Odhiambo	Community Member			
98	Antone Onyango	Community Member			

National Irrigation Board

99	Kalara Odero	Community Member			
100	Rose Sigar	Community Member			
101	Lucy Adhiambo	Community Member			
102	Fredrick Opiyo	Community Member			
103	Anastacia Laja	Community Member			
104	Denis Odhiambo	Community Member			
105	Benta Achieng	Community Member			
106	Tom Laja	Community Member			
107	John Odiemo	Community Member			
108	Josephat Omondi	Community Member			
109	Maria Sigingi	Community Member			
110	Johnson Ouma	Community Member			
111	Sarah Akinyi	Community Member			
112	Kennedy ochieng	Community Member			
113	Daniel Onyango	Community Member			
114	Okoth Omiyo	Community Member			
115	John Lumutu	Community Member			
116	John Amara	Community Member			
117	Lillian Anyango	Community Member			

National Irrigation Board

118	Francis Odongo	Community Member		
119	Marry Atieno	Community Member		
120	Margaret Baraza	Community Member		
121	Marry Obondo	Community Member		
122	Risper Otieno	Community Member		
123	Helida Awino	Community Member		
124	Paskali Auma	Community Member		
125	Benard Owino	Community Member		
126	Andrew Owino	Community Member		
127	Onyango Odemba	Community Member		
128	Winney Owino	Community Member		
129	Cosmas Ouma	Community Member	0723 018968	27037068
130	Jane Anyango	Community Member		6189345

LIST OF PARTICIPANTS IN THE ASSISTANT CHIEF'S BARAZA FOR ELECTING FARMERS REPRESENTATIVES WORKSHOP ON 15TH APRIL 2010 FOR LOWER NZOIA IRRIGATION DEVELOPMENT PROJECT. CONTRACT NO.NIB/T/07/2009-2010

Sub -Location : NYADOLERA `A`				
Location:				
District :				
Provincial Administration Representative : Held at A/chief`s office (compound)on 13th April 2010				

National Irrigation Board

Serial No.	Name of Attendants/Institution	Contact person/Designation	Address & Telephone	ID Number
1	Sylvester O Amuok	0734 883735	Box 17	5356997
2	Dennis Ochieng`	0729 747341	Box 52	28801082
3	Joseph O.Okoth		Box 17	526207
4	Peter Onyango Lasuami	0725 866382	Box 17	7250626
5	Dan Otieno	0726 881146	Box 4	28511337
6	David Omondi		Box 17	27351008
7	DonBosco Osen	0714 279627	Box 17	27144608
8	Billy Kadinla	0710 705804	Box 17	8916626
9	George Ouma		Box 17	22078266
10	Joseph Juma	0715 705804	Box 17	8916626
11	Christine Ouma			11825615
12	Erick Ouma	0728 516095	Box 17	22335723
13	Janes Otieno		Box 17	25280950
14	Jacob Oloo		Box 17	
15	Joseph Otieno Wawuya	0710 697794	Box 9	9286293
16	Lucas Obonyo		9016044 Box 17	
17	Daniel Owino		Box 71	
18	Charlie M.Oduor	0727 868632	Box 17	20905968

19	Jacob Omondi	0711 359434	Box 71	8225289
20	Wilson Ochieng		Box 4	23979651
21	Zaccheaus Okoth Obare	0723 228750	Box 4	21634327
22	Zakaria Oluoch	0725 057171	Box 7	2255653
23	Antony Otieno	0712 900376	Box 4	2878700

LIST OF PARTICIPANTS IN THE ASSISTANT CHIEF'S BARAZA FOR ELECTING FARMERS REPRESENTATIVES WORKSHOP ON 15TH APRIL 2010 FOR LOWER NZOIA IRRIGATION DEVELOPMENT PROJECT . CONTRACT NO.NIB/T/07/2009-2010. Held at Nzoia Market on 14th April 2010

Sub -Location : Unjala				
Location: Central Ugenya				
District : Ugenya				
Provincial Administration Representative : Grace oloo (Ass.Chief)				
Serial No.	Name of Attendants/Institution	Contact person/Designation	Address & Telephone	ID Number
1	James Orucha mumbo	Community Member	0727 034835	4343469
2	Lumumba Olwenge	Community Member	Box 84 Ugunja	987352
3	Patrick Oloo Adwala	Community Member		2678457
4	Charles Onyango	Community Member		6008122
5	Adreur Akula	Community Member		
6	Peter Odera Akwiri	Community Member		
7	Owino Muga	Community Member		6417264

National Irrigation Board

8	Atwosa gek	Community Member	0736 189258	102430	
9	patrick Nyawawa Ofuwe	Community Member	0720 770468	460002	
10	James M. Ofenywa	Community Member		2868883	
11	Phillip O.Onyango	Community Member			
12	Juliana Obonyo	Community Member			
13	Edward Opondo Olwenge	Community Member	075 0667955		
14	Patrick Obare	Community Member			
15	Charles Onyango	Community Member	0728 239256	11438274	
16	Agnes Anyango	Community Member		2861928	
17	Dominik Oyoo	Community Member		9943208	
18	Nicholas Otieno	Community Member		20495995	
19	John Omondi	Community Member			
20	Awino Otieno	Community Member			
21	Lizzy Achieng	Community Member		27231465	
22	Suluwe Omondi	Community Member			
23	Alex Odhiambo	Community Member			
24	Julius Ochidwa	Community Member			
25	Peter Onyango Owino	Community Member		11589000	
26	Wycliffe Owino	Community Member			

National Irrigation Board

27	Opondo Odera	Community Member		20061012
28	Julius Ochweda	Community Member		3482855
29	Nicholas Akwiri	Community Member		
30	Margaret Achola	Community Member		
31	Margaret Auma	Community Member		
32	Cathorina Omondi	Community Member		
33	Susan Apondi	Community Member		
34	Veronicah Akoth	Community Member		
35	Millicent Amloch	Community Member		
36	Rusbela Juma	Community Member		
37	Charles Otieno	Community Member		22507670
38	Vincent Owino	Community Member	0728 159889	24662959

LIST OF PARTICIPANTS IN THE ASSISTANT CHIEF'S BARAZA FOR ELECTING FARMERS REPRESENTATIVES WORKSHOP ON 15TH APRIL 2010 FOR LOWER NZOIA IRRIGATION DEVELOPMENT PROJECT . CONTRACT NO.NIB/T/07/2009-2010 .Held on 13th April 2010

Sub -Location : Kabura Uhuyi				
Location: South West Alego				
District : Siaya				
Provincial Administration Representative :				
Serial No.	Name of Attendants/Institution	Contact person/Designation	Address & Telephone	ID Number

National Irrigation Board

1	Simon O. Olwendo	A/Chief	0720 306444	21015795
2	Conslata Omollo Katiba	A/Chief	0711 974724	8373123
3	Raymond Opiyo Nyadimo	A/Chief	0724 352822	6185538
4	Silvanus Omondi Otieno	Community Member	0727 883524	11670838
5	Michael Oloo	Community Member	0726 7300186	
6	Rose Apondi Opondi	Village Elder	0713 456738	2764647
7	Nicholas Wanga Mambo	Village Elder		508055
8	Raphael Owino	Resident	0721 791696	2878372
9	Thomas Odipo	Resident	0722 593001	7838800
10	Barasa Ochola	Resident		
11	Phillip Ongoe	Resident		
12	Peter Kennedy Omondi	Resident	0720 318377	10433315
13	Cosmos Peter Okwako	Resident	0722 436321	1874001
14	Phillip Akonya Obare	Resident	0722 904500	825592
15	George Ochieng Owino	Community Member		
16	Joseph Okoth Okumu	Community Member	0727 015466	
17	Francis S. Obongo	Community Member		20031312
18	Stephen Ondigo	Community Member	0728 298383	
19	John Penda	Community Member	0716 84272	11824390

National Irrigation Board

20	Joseph okello	Community Member	0719 525587	
21	Vithia Opondo Owour	Community Member		9649552
22	Maurice Ochieng Onyango	Community Member		
23	Dizon Mungoh	Community Member	0727 821955	23549771
24	Floride Omondi	Community Member		
25	Sylvester Odhiambo	Community Member	0725 964803	22382505
26	Cavin Owino Agola	Community Member	0719 296706	27580762
27	Kennedy Ouma	Community Member	0710 697730	28536673
28	Vincent Ocholla Okumu	Community Member	0728 426232	
29	Cornel Ouma Simita	Community Member	071 9561481	
30	Camus Odhimabo Anyango	Community Member	0712 563813	28536587
31	Richard O. Achatch	Community Member	0728 514929	13784700
32	Antonie O.Otieno	Community Member		
33	Fredrick Odhiambo	Community Member	0716 685700	25048061
34	Chrisphine Omondi	Community Member	0712 330951	16118836
35	Fredrick Otieno	Community Member	0712 539016	11611792
36	Chrstopher Otieno	Community Member	0724 455654	
37	Fredrick Aketch Oduor	Community Member	0719 575384	
38	Kerim Oloo	Community Member		

National Irrigation Board

39	Otieno Ouma Expine	Printer /Designer	0727 210897/ 0737 335964	20995820
40	Juliana Awour	Resident		
41	Leunida Ogundo	Community Member		
42	Prisca Omondi	Community Member	0724 506433	20806907
43	Joice Atieno Odhiambo	Community Member		
44	Angeline Adipo	Community Member		
45	Joyce Adhiambo Akumu	Community Member		
46	Francisca Achieng Odhiambo	Community Member		
47	Roddy Antolle	Community Member		
48	Rose Akinyi Ojwang	Community Member	0721 246561	
49	Jenepher Okelo Odour	Community Member	0711 228147	
50	FRANcisca Achieng	Community Member		
51	Jane Anyango Ogutu	Community Member		
52	Janita Abiero Otieno	Community Member		
53	Rosemary Achieng	Community Member		14667855
54	Lilian Omondi	Community Member	0714 821087	11764697
55	Antelina A.Ochieng	Community Member	0713 800750	2879802
56	Gabriel Okumu Opiyo	Community Member	0729 675350	5984593
57	Lucas Onyango Ojow	Community Member	0715 087279	1450738

National Irrigation Board

58	Leo Odude Ogutu	Village Elder	0724 352248	2878404
59	Patric Okello	Village Elder		
60	Michael Onyango	Village Elder		
61	John Owino Ndedo	Village Elder	0723 328841	276343
62	John Oor Onyolo	Village Elder		
63	Raphael Odhiambo	Farmer	0723 221559	2847632
64	Fredrick Ochieng Oduour	Community Member	0715 207624	

B. ISSUES AND RESPONSE REPORT

**ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) FOR THE
PROPOSED IMPROVED WATER MANAGEMENT PROJECT IN LOWER
NZOIA IRRIGATION SCHEME**

ISSUES AND RESPONSE REPORT

MARCH/APRIL 2010

This document records the issues and comments contributed by stakeholders in response to an invitation to comment on the environmental impacts of the proposed improved water management project in Lower Nzoia Irrigation Scheme. A consultation exercise was carried out with stakeholders during the Public Participation process in March/April 2010. The comments and suggestions by stakeholders were made in focused group meetings. The report also includes the responses provided by members of the ESIA team and members of the Project Client team.

The comments have been categorized as follows:

COMMENTS RAISED	COMMENTATOR/S	RESPONSE
BIODIVERSITY		
Will the project have an impact on livestock and grazing areas?	Ouma Evans(Mau Mau)	There will areas provided for your livestock so don't worry
We are poor because of wild pigs, how will the project address this menace?	Aburu Buluma (Mau Mau)	This will be addressed in conjunction with KWS
How will they deal with wild pigs?	Boniface Asembo	
WATER		
Surface water supply and quality		
When there are floods will water in the canals affect people?	Omondi Otieno (Kabura Uhui)	The canals will have gates to control the flow of water.
Use windmill to pump water	Patrick Juma (Mau Mau)	
Groundwater supply and quality		
PROJECT		

COMMENTS RAISED	COMMENTATOR/S	RESPONSE
When will the project start? How will the youth benefit from the project?	Osinya Ayamba Anyiso (Mau Mau)	Youth will benefit from employment.
How will the world bank finance the project?	Erick Nkundi(Mau Mau)	It is a grant but there is need for the farmers to own the project through participation.
How is the compensation of those whose land will be cut the canals and infrastructure be effected?	Aburu Buluma(Mau Mau)	Those affected by major canals will have their cases addressed.
Is the project an extension of dominion farms?	Ouma Evans (Mau Mau)	
What are the methods of identifying project beneficiaries?	Juma Caroline (Mau Mau)	All of you will benefit from the project in one way or another, directly or indirectly.
Women grow crops but they are washed away by floods?	Margaret Atieno (Mau Mau)	
How will those affected by canal construction be compensated?	Boniface Asembo(Magombe)	
Will the world bank buy tractors for farmers?	Michael (Magombe)	No, need to work hard to uplift your standards and buy your own.
Recommend the project to implemented	William Osuri.	
Will you construct a new canal apart from the old existing ones?	David Ouma	This is a different project and new canals will have to be constructed.
If canal passes through your farm will there be compensation? The team should try meeting all the stake holders along the river?	Dennis Ochieng (Nyadorera A)	
When will the project commence? If the canal passes in your farm and affects your project how will you deal with it?	Eric Ouma (nyadorera A)	The project has already started. We will deal with it by discussing with the affected persons and by using valuers, we will be able to compensate appropriately. You will have the right to appeal if you are not satisfied.

COMMENTS RAISED	COMMENTATOR/S	RESPONSE
If the project stalls because of political interference or misuse of funds will the project be abandoned?	Rafael Owino (Kabura Uhui)	The will be workshops were you will be able to air your concerns. Any misuse of funds will be dealt with firmly.
What happens if you don't agree with the compensation of the project?	Lilian Omondi (Kabura Uhui)	There will be enough discussion with those affected and between the farmers who are supposed to own the project to avoid such a situation.
What is the size of the canal and its length from the river?	Rafael Akumu(Kabura Uhui)	The size of the canal will depend on the amount of water to convey and this is still in the engineering stage.
What size of land of our sub location will be used in the project?	Peter Omondi (Kabura Uhui)	We will know once survey is done, also the project is likely to end where topography changes and does not allow flow of water by gravity.
Is this project and experiment or has it been done elsewhere?	Dickson Nungu (Kabura Uhui)	This is a serious project and mostly depends on your commitment.
Is the project for Usonga people or for those only along the Nzoia river?	Meshach Ayeko	This project is collectively for the people of the lower Nzoia.
Those relocating will they be compensated?	John Odino (Nyadorera B)	Yes there will be compensation according to the value of property to be affected.
Those not benefiting from the project directly, are their other ways?	Christopher Otieno(Nyadorera b)	You will be able to start business, work in farms, and transport produce.
Is the money from the World Bank a grant or a loan?	Margaret Opondo (Nyadorera b)	The money is a grant but people will have to show their commitment for the project to move on smoothly.
LAND		
Where is the land that you say you are going to implement the project?	Anastasia Laja	Your farms are what forms this project and they will manage by you.
How do you deal with those having ½, ¼ acres of land?	George Kanoti (Nyadorera B)	This people will be able to work in their farms and also provide workforce in other farms.

COMMENTS RAISED	COMMENTATOR/S	RESPONSE
WATER RESOURCE AND FLOODS		
Water will flow from Nzoia by gravity and the area is low land, will it not flood? Stagnation of water will cause malaria?	William Osuri (Mau Mau)	
Sugar factories dispose chemicals into the river and it will affect the crops to be irrigated?	Patrick Juma (Mau Mau)	
Water logging in those areas that flood? Will canal pass through the areas that flood?	Gladys Aluanga	Survey has been done to address the issues of flooding.
During flooding of Nzoia River, canals will be conveying water what happens at that time?	Thomas Odipo	Canals will have gates to control flow of water.
When there are floods will water in the canals affect people?	Omodi Otieno	The canals will have gates to control the flow of water.
EMPLOYMENT		
Development is good but the elderly are taking youth opportunities?	Christopher Wanja (Magombe)	The project is to benefit all.
How can we dig canal by hand?	Alfred Muyumba (Mugombe)	It will provide employment.
Those to work in the project where will they come from?	George Oketch	People from the project area will be given priority before those from other areas.
Which criteria will be used to select people for employment	Patrick Odiambo	You will be informed by the various committees that will be formed by you farmers.
SOCIO-ECONOMIC ISSUES		
Fisheries		
ISSUES RELATED TO THE ESIA		
Scoping Report and Specialist studies		

COMMENTS RAISED	COMMENTATOR/S	RESPONSE
Public participation		
ESIA process		
NEED AND DESIRABILITY OF THE PROPOSED PROJECT		
OTHER ISSUES		
<p>Will you help you help the people till the end when they start selling their produce?</p> <p>Will this project be finished?</p>	<p>Sylvester Nduasi (Sumba)</p>	<p>The project has been funded by the world bank and this should be able to complete the project.</p>

C.QUESTIONNAIRE

D. CULTURAL SITES AND LOCATION

Name of Cultural Site	Locations	Description
Ainga	Bukhunja	
Ainga	Namabusi	
Ainga	Bangoma	
Ainga	Mwalo	
Ancestral Homes	Wang Chieng	Traditional residential houses
Ancestral Homes	Manga	
Ancestral Homes	Kanyajer	
Bunyinyi	Bukeki	
Disi Swamp	Kalkada	Wetland area
Embuho	Kalkada	
Kabura Uhuyi Swamp	Kabura Uhuyi	Wetland area
Kalkada School	Kalkada	Education institute and recreation facility
Kalkada School	Nyabera B	
Kaya	Rukala	
Khalanga	Bukanga	
Lidende	Uchonja Village	
Luingo	Salambaki	
Mukaya	Rukala	
Musoma	Musoma School	
Musumba	Bukeki	
Nabala	Busonga	
Nakhabuka	Magombe Central	
Nakhubuka	Mubwayo	
Nakhubuka	Bukwanga	
Nambala	Siriwo	
Nambala	Sumba	
Ndegwe Branch	Ndegwe Village	

National Irrigation Board

Ndekwe	Mabinju	
Ndekwe	Bukhunja	
Ndekwe	Namabusi	
Ndekwe	Bakhone	
Nomukhi	Khainge Lugahi	
Nyokio	Uhuyi Village	
Omia	Rukala	
Oyugis	Kalkada	
Playing Field	Nyadorera A	Recreation and sports facility
Samba	Uwasi	
Sports Ground	Siagajo Rugunga	Recreation and sports facility
Sports Ground	Sigomere	
Sports Ground	Makhoma Lugale	
Sumba	Singinga	
Sumba	Lunyofu	
Ulalo	Kalkada	
Uradi Church	Kagomo	Religious and prayer centre
Uradi Church	Uradi	
Wrestling Ground	Makhoma Lugali	Recreation and sports facility
Wrestling Ground	Sigomere Rugunga	

E. SOIL CODES

Code	Description
AA1	somewhat excessively drained to well, very deep, light yellowish brown to yellowish brown, loose sand (ferralic ARENOSOLS)
AA2	Moderately well drained, deep reddish brown to dark brown, mottled, firm, slightly sodic clay; in places stratified and non-sodic (chromic VERTISOLS, saline and sodic phase)
AA3	Imperfectly drained to poorly drained. Deep, dark brown to dark yellowish, mottled, very firm, slightly sodic, cracking clay (chromic FLUVOSOLS, saline and sodic phase)
AAC	Complex of well drained to poorly drained, deep, mottled, stratified soils of carrying colour, consistence, salinity and texture (eutric FLUVISOLS and eutric CAMBINOLS, saline phase)
BX1	Imperfectly drained to poorly drained, deep, dark brown to dark yellowish brown, mottled, very firm, strongly calcareous, slightly sodic, cracking, silty clay to clay (calcare-chromic VERTISOLS, sodic phase)
BXC	Complex of: <ul style="list-style-type: none"> – Moderately well drained to poorly drained, very deep, greyish brown to very dark grey, loose, sand to loamy sand, 70 to 100cm thick, overlying greyish brown, mottled, firm, sandy clay to clay – Imperfectly drained, deep, dark brown, friable to firm, cracking clay, underlying 20 to 30cm of black, very firm clay (pellic VERTISOLS and vertic GLEYSOLS) – Imperfectly drained to poorly drained, deep to very deep, grey to dark grey, mottled, friable to firm, sandy clay loam to clay (plinthic and eutric GLEYSOLS)
FIM	Well drained, shallow, dark red to dark yellowish brown, gravelly, clay loam to clay, over petroplinthite (murrum)/rock (LITHOSOLS and ferralic CAMBISOLS, petroferic phase)
HIP	Excessively drained, shallow, yellowish red to dark reddish brown, rocky, stony, gravelly, clay loam to sandy clay (LITHOSOLS, stony phase)
SA1	Imperfectly drained, deep, dark yellowish brown to very dark grey, mottled, firm, slightly saline and strongly sodic, clay loam to clay (gleyic SOLONCHAKS, sodic phase)
SA3	Poorly drained, deep, olive grey to very grey, mottled, firm clay, underlying 50-150 cm of brown peat or black soft organic matter (humic GLEYSOLS and dystric HISTOSOLS)
SAC1	Complex of: <p>Imperfectly drained, deep soils of varying colour, consistence, calcareousness, salinity, sodicity and texture (chromic VERTISOLS, saline and sodic phase and vertic* FLUVISOLS)</p> <p>Poorly drained, deep, dark brown to dark greyish brown, mottled, soft to firm, peaty clay to clay (eutric HISTOSOLS and humic GLEYSOLS)</p>
UDb1	Well drained, deep to very deep, yellowish red to strong brown, friable to firm, clay (orthic ACRISOLS and dystric CAMBISOLS)
UDb2M	well drained to moderately well drained, shallow to moderately deep, yellowish red to

	strong brown, friable to firm, clay over petro-plinthite (murrum) (ferralic CAMBISOLS, petroferric phase)
UDr3m	Well drained, moderately deep to deep, red to dark red, friable to firm, clay, over petroplinthite (murrum); in places petroplinthite at the surface (rhodic FERRALSOLS and chromic* ACRISOLS; petroferric phase)
UGb2	Well drained, deep yellowish rd to dark brown, firm, sandy clay, with many rock outcrops
UGb4m	Well drained to moderately well drained, moderately deep to deep, strong brown, friable to firm, fairly rocky, bouldery, gravelly, sandy clay to clay, over petroplinthite (murrum) rock (orthic ACRISOLS and orthic FERRALSOLS, stony and petroferric phase)
UGr2-UGb3M	Complex of soils of units Ugr2 and Ugb3M
UGr3m	Well drained, moderately deep to deep, red to yellowish red, friable to firm, fairly rocky, bouldery, clay, over petroplinthite (murrum) (rhodic FERRALSOLS, stony and petroferric phase and chromic* ACRISOLS)
Ulr	Well drained, deep, red to dark red, friable to firm, clay; in places shallow to moderately deep, over petroplinthite (murrum) (chromic* ACRISOLS, partly petroferric phase)
UVb3P	Well drained, shallow, strong brown to dark yellowish brown, rocky, very bouldery, fairly stony, gravelly, clay loam to clay (dystric CAMBISOLS, lithic and stony phase)
VXC2	Complex of: Well drained, deep, reddish brown to dark brown, firm, sandy clay to clay Well drained, shallow to moderately deep, yellowish brown to dark yellowish brown, firm, sandy clay loam to clay, over petroplinthite (murrum)/rock. (ferralic CAMBISOLS, petroferric phase) Imperfectly drained to poorly drained, deep to very deep, dark greyish brown to black, mottled, stratified, firm clay (dystric GLEYSOLS and vertic* FLUVISOLS, sodic phase)

SLOPE CLASSES

- A. Flat to gently undulating
- B. Gently undulating
- C. Undulating
- D. Rolling
- E. Hilly

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