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DRAFT STUDY REPORT

FOR

STRATEGIC ENVIRONMENTAL ASSESSMENT (SEA) FOR EXPANDED IRRIGATION PROGRAMME AND NATIONAL ECONOMIC PROGRAMME IN THE TANA AND ATHI BASINS

PREPARED BY

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CERTIFICATION

This Draft SEA Study Report has been prepared in line with the provisions of the Environmental Management and Coordination Act (EMCA) Amendment of 2015, Environmental (Impact Assessment and Audit) Regulations, 2003 and the Strategic Impact Assessment (SEA) 2012 for submission to the National Environment Management Authority (NEMA).

We the project proponent and the SEA Firm of Experts certify that the particulars given in this report are correct to the best of our knowledge.

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NON-TECHNICAL SUMMARY

1.0 Objectives of SEA

The SEA process aims to systematically integrate environmental considerations into planning, and decision-making processes. The study seeks to ensure that programme implementation does not lead to pollution of water resources to levels that would damage natural systems; ensure that water abstraction, run off and recharge within programme area is maintained within carrying capacity of local rivers; ensure that soil contamination is reduced and soil quality safeguarded; and minimise solid waste arising from activities associated with the proposed programmes. Other objectives include to ensure sustainable management of key wildlife sites and the ecological processes on which they depend; reduce vulnerability of the local people to the effects of climate change including crop failures and flooding; and to give access to satisfying and rewarding employment opportunities through employment creation in the agricultural sector among others.

2.0 Indicators

A number of indicators will be used to ascertain levels of environmental and resource degradation associated with implementation and operation of programme activities. They include quality status (biology and chemistry) of rivers within the programme area; quality and quantity of groundwater within the programme area; water availability for water-dependent habitats, especially designated wetlands; water availability for competing uses; land identified as derelict within the programme area during programme operation phase (number of hectares); hectares of contaminated land in programme area and amount of waste generated during construction and operation phases of project components. Other indicators include achievement of Biodiversity Action Plan targets; conditions of nationally important wildlife sites, Sites of Special Scientific Interest (SSSI) etc., employment opportunities created through agricultural enterprises and increase of income levels among the local people.

3.0 Methodology for the Study

The SEA process was guided by the National Guidelines for SEA in Kenya and the Environmental Impact Assessment and Audit Administrative Procedures. The SEA process also used an integrated approach and considered international prescriptions, national laws and best practices during the study. Methodologies used in this study include screening, scoping and detailed SEA study. Screening was undertaken to determine whether the proposed programmes required a SEA process while scoping was used to determine the focus, extent, content, approach, and criteria of SEA study. Detailed study involved collection of social, economic and environmental data and information within programme area for purposes of determining how the programmes fit within the local setting.

4.0 Objectives of the Pogrammes

The objectives of the NIB's programmes include accelerating irrigation expansion and development; improving performance of irrigation and drainage infrastructure through rehabilitation; improving provision

of operation and maintenance services; increasing efficiency in water utilization and strengthening capacity of farmers and farmer organizations for management of irrigation systems. Other objectives include improving land tenure systems; improving financial sustainability of public irrigation schemes; and improving agricultural and land productivity in irrigation schemes.

5.0 Areas and sectors affected

The areas to be affected by programme activities are those that are drained by Athi and Tana Rivers and their tributaries and include nineteen counties in total. A number of sectors including agriculture, water, forestry, Public Health and wildlife will be affected by programme activities. Intensification of agriculture is highly likely to result in the intensification of problems from pests and diseases hence affecting the internal dynamics of agricultural sector. Intensified cropping systems will rely on improved crop varieties which tend to require agrochemical inputs to reach their yield potentials. Uncontrolled use of agrochemical will impact on public health of the local people arising from use of pesticides and agrochemicals. At operation phase, the projects under the programmes will require large volumes of water from nearby water sources which may result in strain on the available water resources for competing uses. Vegetation clearance within project alignment area may lead to destruction of forestry resources which are wildlife habitats. This will negatively affect wildlife and forestry resources. More importantly, construction works will reduce available feeding and breeding habitat for local fauna, and may affect access to vegetative resources within the project alignment area.

6.0 The proposed programmes

Two programmes are under investigations in this study and they include the National Economic Programme (NEP) and Expanded Irrigation Programme (EIP). Under the NEP is the Galana/Kulalu Food Security Project where the government targets to put 1 million acres under irrigation and other enterprises by 2017. Expanded Irrigation Programme aims to attain national food security in Kenya by eliminating hunger amongst Kenyans through acceleration of coverage of the 1.7 million acres potential irrigation land in the country which will ultimately make Kenya a net exporter of food. The programme aims to develop 540, 000 ha of land for irrigation in 5 major river basins, among them Tana and Athi river basins in order to improve sustainability in agriculture and production through irrigation. This will in turn increase food security by expansion of areas under irrigation which will in the long run enhance income levels of the farmers and raise living standards of about 1,525,400 households within the targeted areas

7.0 Programme activities

In order to achieve the targets set for irrigation development, an implementation plan covering the period from 2011-2030 has been prepared. Activities to be undertaken during project implementation include financing civil works and non structural interventions; contracting and supervision of the construction works to completion for the ongoing projects; tendering, contracting and supervision of construction works to completion for the projects with tender documents ready for implementation; financing of the feasibility and detailed design studies and carrying out feasibility studies, detailed study, design, tendering, contracting and supervision of construction work for the projects at preliminary design/Identification/Investigation stage.

Other activities include updating of feasibility study reports; conducting detailed design and preparation of tender documents; tendering contracting and supervision of construction work for the projects whose feasibility studies are complete; upgrading of feasibility studies; design and tender documents review; tendering, contracting and supervision of construction for the projects with design documents ready; and handing over of the completed works to the beneficiaries.

8.0 Pressures and trends within the study area

Socio-economic activities as currently practiced within Tana and Athi River basins have led to various pressures on available resources. The pressures in Tana River basin include inappropriate land use; overutilization of water; conversion of land to agriculture; overstocking of livestock; conversion of land to settlements; loss of catchment forests; increased demand for resources; reduced water levels; and land subdivision and fragmentation. In Athi River basin, pressures include over-exploitation of surface and ground water resources; wetland resources degradation; unregulated diversions of river channels; catchment degradation due to overgrazing and sand harvesting; land use changes for settlement and agriculture; and climate change and variability. These pressures have led to a number of environmental and socio-economic impacts including pollution of local water bodies; soil erosion/ siltation; overgrazing; reduced water volume in local water bodies; loss of critical habitats and species; and reduced hydrological capacity. Other impacts include acute water scarcity due to high water demand; limited ground water recharge; changing river regime and pollution of water resources from industrial effluents, agricultural and domestic waste.

9.0 Planned and existing projects

There are a number of existing and planned projects within the programme area that are likely to compete for resources with projects under the proposed programmes. Major projects include Lamu Port-Southern Sudan-Ethiopia Transport (LAPSSET) corridor project; construction of High Grand Falls; expansion of Mwea Irrigation Scheme; construction of Galana/ Kulalu Food Security Project (GKFSP) and construction of Thiba Dam. Others projects include construction of Munyu Multipurpose Dam; Tana Delta Irrigation Project; Northern Collector Tunnel Project; Thwake Multi-Purpose Dam and Mt Kenya Ecosystem Management Plan among others. The development of the projects will open up the region for investment, create considerable demand for goods and services in the area with a strong impact on economic activities which may aggrevate competition for resources.

10.0 Potential impacts of the proposed programmes on the environment

(i) Socio-economic impacts associated with programme activities include increase in crop production area, increase in fisheries and tourism opportunities and increase in food and income. Employment opportunities will also be available to local people especially in water related sectors;
(ii) Dams will affect the social, cultural and economic structure of the region considerably, especially forcing people, whose settlement areas and lands fall within the dam area to migrate affecting them socially and psychologically;

(iii) Public health impacts related to programme activities include increase in incidents of water-borne or water-related diseases which are commonly associated with basin irrigation. The diseases most directly linked with irrigation are malaria, bilharzia (schistosomiasis) and river blindness (onchocerciasis), whose vectors proliferate in the irrigation waters;
(iv) Individual projects under EIP and NEP like construction of Thiba and Galana-Kulalu dams will check on floods downstream. As a result of damming, decreasing amounts of fresh water are available to maintain ecological values and related ecosystem services e.g. stream migration of aquatic animals during breeding;
(v) Intensification of agriculture is likely to result in intensification of problems from pests and diseases;
(vi) Construction activities will involve some vegetation clearance within project alignment areas especially at the intake works and access roads. Expansion of agricultural lands will also lead to vegetation clearance greatly interfering with wildlife habitats within the affected areas;
(vii) During the operation stage, crops on the farms could be affected adversely through encroachment by wildlife. This may lead to perpetual human-wildlife conflicts;
(viii) Irrigation projects have contributed to pollution of water bodies through release of agrochemicals. Pollution of water resources within the project area will impose a high cost on the economy through detrimental health impacts and increased treatment costs for drinking water;
(ix) Conflicts between pastoralists and farmers may intensify especially in lower Tana area and sections of Athi River basin. This will be excercabated by conversion of hitherto grazing fields into agricultural lands; and
(x) An upsurge in catchment degradation within the programme area through cutting down of trees may lead to loss of economically significant fauna and flora and degradation of environmentally important areas.

11.0 Project Options

Three project options have been analysed in this study and they include maintenance of status quo “No Programme” option; implementation of NIB programs as proposed and conservation- oriented option. The “No programme option” presupposes a situation where the local farmers will continue with their current agricultural practices. Option 2 will involve implementation of NIB programmes as proposed while conservation oriented option will explore opportunities for strengthening the proposed programmes in order to enhance environmental sustainability and optimise resource use. Some of the salient features of the conservation-oriented option include providing alternative water points to persons who may be adversely affected by the operation of the programmes as proposed; mapping all water resources and wetlands within the catchment and protecting them ; putting together some small scale irrigation schemes to form medium or large scale schemes with a provision of common intake to assist in regulating water abstractors; ensuring that any expansion or development of an irrigation project within programme area should be storage based and building the capacity of the water users so that they are equipped with basic monitoring skills.

12.0 Justification for the preferred alternative

The preferred option is justified by a number of factors that collectively contributes to its significance. The option will lead to conservation of critical natural resources within programme area and ease pressures on the basin which have resulted from socio-economic activities as currently practiced. These pressures will be managed through conservation-based agriculture proposed in the programmes under study. The option will also result in water resources conservation through putting together some small scale irrigation schemes to form medium or large scale schemes with a provision of common intake to assist in regulating the water abstractors and at the same time ensure that any expansion or development of an irrigation project shall be storage based and efforts will be made towards building the capacity of the water users within the programme area so that they are equipped with basic monitoring skills. The option will encourage community dialogue which will be spearheaded through establishment of more Water Resources Users Associations (WRUAs) within programme area. More importantly, irrigation will ensure the production of adequate food and thus improve households' nutritional intake and help alleviate poverty by raising farm incomes.

13.0 Linkages with ongoing projects

A number of on-going projects are linked to the programmes under consideration in a number of ways including sharing common resources, sharing funding agencies and benefiting from common management institutions. The projects also find confluence with the programmes through sharing common objectives. Some of the projects linked to the programmes include Lamu Port-Southern Sudan-Ethiopia Transport (LAPSSET) Corridor project; High Grand Falls; Expansion of Mwea Irrigation Scheme; Galana/ Kulalu Food Security Project (GKFSP); Construction of Thiba Dam; Construction of Munyu Multipurpose Dam; Tana Delta Irrigation Project; Northern Collector Tunnel Project; Thwake Multi-Purpose Dam; Community irrigation projects and projects initiated by County Governments

14.0 Recommendations

14.1 Recommended PPP changes

The following changes among others should be made to the programmes to increase their environmental sustainability and social acceptability.

(i) There is need of putting together some small scale irrigation schemes envisaged in the programmes to form medium or large scale schemes with a provision of common intake to assist in regulating water abstractors and make it manageable in providing water, especially if storage has to be put in place;
(ii) A metering system should be put in place for every farmer to ensure effective management of the water use;
(iii) There should be a deliberate move to create storage in all rivers where good sites of dams exist so that the flood water can be stored and later used for irrigation during dry periods;
(iv) Any expansion or development of an irrigation project within the programme area should be storage based since water resources within the two basins are already strained as a result of competing uses; and

(v) There should be a continuous and systematic capacity building of community members within the irrigation schemes. Capacity of farmers should be built on water management, environmental conservation and operation and maintenance of irrigation infrastructure; Illegal abstractors must be controlled through river basin patrols and all abstraction points should be destroyed and persons found to be illegally abstracting water from local rivers made to account;

14.2 Recommended mitigation measures

(i) Map all water resources and wetlands within the programme area and protect them from degradation in compliance with existing rules and regulations.
(ii) Project areas should be fenced off and some corridor left to facilitate wildlife movement to the local rivers. Corridors should also be left between project areas and wildlife dispersal areas especially for projects bordering National Parks and Game Reserves.
(iii) Training should be provided to local farmers on fertilizer and pesticides use.
(iv) Put together some small scale irrigation schemes to form medium or large scale schemes with a provision of common intake to assist in regulating water abstractors;
(v) A system of metering for every farmer should be put in place to ensure effective and efficient management of water use.
(vi) Adequately compensate affected persons for any resource lost as a result of proposed programme activities. This should be achieved through proper valuation of resources affected;
(vii) Reduce illegal abstractions, especially in the upstream section of the River Tana by bringing illegal water users into the permit system;
(viii) Regular patrolling should be done since it discourages illegal use and ensures that water abstractions are in line with legal provisions; and
(ix) Spearhead community dialogue through establishment of more Water Resources Users Associations (WRUAs).

14.3 Recommended alternative

The option that has been recommended for implementation is the conservation oriented alternative (Option 3). This option has explored opportunities for strengthening the proposed programmes in order to enhance environmental sustainability and optimise resource use. Under this alternative, technologies for water harvesting, farming methods to be used, linkage of farmers to the market, agricultural mechanization, existing farm sizes and provision of input and credit to farmers have been analysed. Irrigation and technologies for water harvesting as they relate to adoption of innovative concepts have also been analysed. Irrigation intensification has been considered in terms of application of best practices towards utilization of developed irrigation space and scarce water to realize better crop production. The applicable modern irrigation technologies have been looked at from the point of view of improvement of efficiency in water use.

15.0 The need for subsequent Environmental Impact Assessments (EIAs)

There are a number of projects falling under programmes whose future implementation may lead to significant environmental impacts which can only be addressed through an elaborate process of project level Environmental Impact Assessment. They include among others:

(i) Major agricultural activities under Galana-Kulalu Food Security Project;
(ii) Urban development projects under Galana- Kulalu Food Security Project;
(iii) Tourism Development under Galana- Kulalu Food Security Project;
(iv) Large scale irrigation/agricultural projects with area coverage of more than 2000 acres;
(v) Projects that involve displacement of populations; and
(vi) Development of major water storage dams.

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ACRONYMS AND ABBREVIATIONS

ASALs	Arid and Semi-Arid Lands
ASDS	Agricultural Sector Development Strategy
AWSB	Athi Water Services Board

BCM	Billion Cubic Meters
CAN	Calcium Ammonium Nitrate
CFA	Community Forest Association
CIDA	Canadian International Development Agency
CBOs	Community Based Organizations
DAP	Diammonium Phosphate
DOSHS	Directorate of Occupational Safety and Health Services
EAC	East African Community
EIP	Expanded Irrigation Programme
EMCA	Environmental management and Coordination Act
EMP	Environmental Management Plan
EPA	Economic Partnership Agreement
ESIA	Environmental and Social Impact Assessment
ESP	Economic Stimulus Programme
FSNP	Food Security and Nutrition Policy
GKFSP	Galana-Kulalu Food Security Project
GoK	Government of Kenya
GDP	Gross Domestic Product
IDD	Irrigation and Drainage Department
KARI	Kenya Agricultural Research Institute
KFW	Kreditanstalt Fur Wiederaufbau
IDWS	Irrigation Drainage and Water Storage
IFAD	International Fund for Agricultural Development
ISH	Individual smallholder
IUCN	International Union for Conservation of Nature and Natural Resources
IWUAs	Irrigation Water Users Associations
KENGEN	Kenya Electricity Generating Company Limited
KFS	Kenya Forest Service
KIRIWASCO	Kirinyaga Water and Sanitation Company
KWS	Kenya Wildlife Service
LAPSSET	Lamu Port-Southern Sudan-Ethiopia Transport
MAP	Mono-Ammonium Phosphate
MCM	Million Cubic Metres
MKEPP	Mount Kenya East Pilot Project
MoALF	Ministry of Agriculture, Livestock and Fisheries
MoWI	Ministry of Water and Irrigation
MENR	Ministry of Environment and Natural Resources
MTP	Mid Term Plan
NALEP	National Agriculture and Livestock Extension Programme
NCPB	National Cereals and Produce Board
NEP	National Economic Programme
NGOs	Non- Governmental Organizations
NIB	National Irrigation Board

PIOs	Provincial Irrigation Offices/Officers
PPP	Policies Plans and Programmes
RFP	Request for proposals
SEA	Strategic Environmental Assessment
SIDA	Swedish International Development Agency
TDIP	Tana Delta Irrigation Project
TMWDP	Thwake Multipurpose Water Development Project
TWSB	Tana Water Services Board
TARDA	Tana and Athi Rivers Development Authority
TOR	Terms of Reference
UNEP	United Nations Environment Programme
UTaNRMP	Upper Tana Natural Resource Management Project
WARMA	Water Resources Management Authority
WRUA	Water Resource Users Association

CHAPTER 1

1.0 INTRODUCTION

1.1 Strategic Environmental Assessment (SEA)

Strategic Environmental Assessment (SEA) refers to a range of analytical and participatory approaches to integrate environmental consideration into policies, plans, or programs (PPP) and evaluate the interlinkages with economic and social considerations. SEAs are approaches for obtaining and evaluating environmental information prior to its use in decision making in the development process (NEMA 2012: p.8). Consistent with Agenda 21 principles, SEA is a proactive approach to integrate environmental considerations into the higher levels of decision-making. SEAs include prediction and evaluation of social, economic and health impacts as well as environmental impacts of plans, policies and programmes. The principles upon which SEA is based include the following:-

(i) Sustainable development and sustainable use of natural resources;
(ii) Enhanced protection and conservation of biodiversity and physical surroundings;
(iii) Inter-linkage of human settlement and cultural issues;
(iv) Integration of socio-economic and environmental factors;
(v) Interactive and inclusion of public and stakeholder engagement;
(vi) Focus on broader environmental and social issues rather than on site-specific impacts in order to resolve issues that cannot be addressed at the project level; and
(vii) Identification and comparison of alternative scenarios.

1.1.1 Legal context of SEA

Regulation 42 of the Environmental (Impact Assessment and Audit) Regulations 2003 requires all proposals for public policy, plans and programmes to be subjected to SEA. Section 43 (3) of the Regulation commit the government and all lead agencies to incorporate SEA principles in the development of sectoral, national and regional policies.

1.2 Objectives of SEA

The Strategic Environmental Assessment for NIB's National Economic Programme (NEP) and the Expanded Irrigation Programme (EIP) within Tana and Athi River basins aims to systematically integrate environmental considerations into planning and decision-making processes. The assessment aims to achieve the following general objectives:

(i) To limit water pollution within programme area to levels that do not damage natural systems;
(ii) To maintain water abstraction, run off and recharge within carrying capacity of local rivers;
(iii) To reduce soil contamination and safeguard soil quality;
(iv) To minimise solid waste arising from proposed activities and find possibility of waste recovery through recycling and composting;

(v) To avoid damage to designated wildlife sites and protected species within the programme area;
(vi) To maintain biodiversity within the programme area by avoiding irreversible losses;
(vii) To ensure the sustainable management of key wildlife sites and the ecological processes on which they depend;
(viii) To reduce vulnerability of local people to the effects of climate change including crop failures and flooding;
(ix) To give access to satisfying and rewarding employment opportunities to local people through employment creation in the agricultural sector; and
(x) To increase investment in agriculture within the programme area.

The table below gives a summary of SEA objectives, indicators and criteria applicable to this study.

Table 1. 1: SEA objectives with suitable indicators and criteria

Objectives	Indicators	Criteria
To limit water pollution within programme area to levels that do not damage natural systems	• Quality (biology and chemistry) of rivers, within the programme area. • Quality and quantity of groundwater within the programme area	• Will it protect and enhance the region's water quality? • Will it increase water pollution? • Will it enhance the area's groundwater quality and quantity?
To maintain water abstraction, run off and recharge within carrying capacity of local rivers	• Water use (by sector, including leakage), availability and proportions recycled • Water availability for water-dependent habitats, especially designated wetlands • Water availability for competing uses	• Will it increase the amount of water used by various sectors? • Will it increase quantity of water available to water-dependent habitats? • Will it increase water available for competing uses
To reduce soil contamination and safeguard soil quality	• Amount/loss of greenfield / brownfield land and proportion available for reuse • land identified as derelict within the programme area (number of hectares) • Hectares of contaminated land in programme area	• Will it lead to increase in soil erosion? • Will it lead to increase in land degradation within the programme area?
To minimise solid waste arising from proposed activities and find possibility of waste recovery through recycling and composting	• Amount of waste generated as a result of proposed programmes • Waste disposed of in landfills • Percent of waste recycled or reused	• Will it reduce the amount of waste generated within the programme area? • Will it reduce the amount of waste set for land fill? • Will it improve the opportunities for recycling?
To avoid damage to designated	• Reported levels of damage to	• Will it have detrimental impact on

wildlife sites and protected species within the programme area	designated sites/species	designated sites/species
To maintain biodiversity within the programme area by avoiding irreversible losses	• Achievement of Biodiversity Action Plan targets	• Will it encourage or preserve woodland cover?
To ensure the sustainable management of key wildlife sites and the ecological processes on which they depend	• Conditions of nationally important wildlife sites, Sites of Special Scientific Interest (SSSI) etc.	• Will it protect and enhance existing priority habitats and species within the programme area?
To reduce vulnerability of the local people to the effects of climate change including crop failures and flooding	• Amount of development in the floodplain • Flood risk	• Will it reduce risks from flooding? • Will it ensure no new inappropriate developments in the flood plain? • Will it manage the effects of climate change from flooding?
To give access to satisfying and rewarding employment opportunities through employment creation in the agricultural sector.	• Employment opportunities created through agricultural enterprises • Increase of income levels among the local people	• Will it create new employment opportunities? • Will it improve income levels of local farmers?
To increase investment in agriculture within the programme area.	• Investment in agricultural production	• Will it increase investment in agriculture?

1.3 Methodology for the Study

1.3.1 General

The SEA was guided by the National Guidelines for SEA in Kenya and the Environmental Impact Assessment and Administrative Procedures. The SEA process also used an integrated approach and considered international prescriptions, national laws and best practices. It further took cognizance of the realities of the institutional setup in the country. In undertaking the SEA, the main focus was on identifying potential environmental, social and economic impacts of the proposed programme, the significance of these impacts, and coming up with possible mitigation and enhancement measures for adverse and positive impacts respectively. Cumulative impacts were also considered in the study.

1.3.2 Screening

Screening was undertaken to determine whether National Economic Programme and Expanded Irrigation Programme required an Environmental and Social Impact Assessment (ESIA), or a Strategic Environmental Assessment (SEA). After consultations with the National Environment Management Authority both at the provincial and national levels, it was determined that a SEA study would be required for the programmes due to anticipated impacts from associated activities and geographical coverage of the programme area.

1.3.3 Scoping

Scoping is one of the initial stages of undertaking a SEA study and principally determines the focus, extent, content, approach, and criteria of the study. Key issues determined by the scoping exercise include:-

- Objectives of the SEA study;
- Decision criteria as well as suitable indicators of desired outcomes;
- Alternatives to be considered;
- Spatial and temporal dimensions of the study;
- Criteria for the assessment;
- Significant issues to be studied;
- Stakeholders to be consulted;
- Methods of data analysis;
- Sources of relevant data as well as amount of information available;
- Justification of the scoping methodology;
- Impacts excluded and justification thereof; and
- Expertise undertaking the study.

1.3.4 The SEA Study

A number of activities were carried out by the SEA team during study process. Activities carried out during this stage include the following:

1.3.4.1 Discussions with the Client

The SEA team maintained close consultative discussions with the client during the SEA exercise. For instance, identification of venues for institutional as well as community consultations was done in consultation with the client. Such identification of venues also aimed to mobilise a wide cross- section of stakeholders as possible, as well as take cognisance of different socio-economic differences among the target groups. Gender representation was deliberately ensured, while efforts were also made to ensure that individuals attending the consultative meetings were truly representative of the community.

1.3.4.2 Identification of Data Sources

Sources of both primary and secondary data were identified at the scoping stage of the study. The data identification process primarily established information requirements and where such information would be sourced from. The SEA assessment relies heavily on trend analysis, so data covering a time-series is most useful. Available national, County and Sub County level data were all captured. Some location specific data (through observation, questionnaire, and interviews) were also collected. The tables below give summaries of data sources during SEA study.

Table 1. 2: Biological data sources

Biological	Data type	Source
Habitats, including wetlands & Fish habitat	• Trends in fish catches • Trends in hyacinth & algal blooms • Habitat Maps (e.g., wetlands; important bird areas)	• State of Environment (SOE) Reports • District Env. Action Plans
Forests	• Maps showing protected areas & forest (over time) • Trends in deforestation	• Trends in land use and forests in SOE reports; and • WRI Nature's Benefits in Kenya(Atlas)
Habitat resilience to climate change	N/A	• Ministry of Environment and Natural Resources (MoENR) documents related to Climate Action Plan • JICA climate model for Water Master Plan

Table 1. 3: Physical data sources

Physical		Data type	Source
Soil & Land	Soil & soil erosion	• Soil type, pH, water retention capacity, organic matter, vulnerability to erosion, and fertility	• Ministry of Agriculture (MoA) documents • Farmers (who can comment on yields when top soil is washed away and on their erosion-control measures) • County Integrated Development Plans (CIDPs)
	Soil & pollution by agro chemicals	• Map of soils / areas already contaminated	• NEMA (State of Environment Report) • MoA • Farmers & expert observations • County Integrated Development Plans (CIDPs)
	Land Use	• Land classification • Major crop growing areas • Agro-ecological zones • Acreage under cultivation: irrigation area estimates on perennial crops and annual	• SOE report • National Irrigation Board and Ministry of Agriculture documents • County Integrated Development Plans

		crops per basin over the last 5 years	(CIDPs)
	Land Characteristics	• Topography, geology, soil types, soil degradation (extent of compaction)	• GIS systems
	Land Use Change	• Maps (series)	• Internet • County Integrated Development Plans (CIDPs)
Water	Water catchment	• Drainage basins • Hydrology (including annual flow intensities and quality indicators, -/silt loads	• SOE reports; • Documents / Internet GIS; • Farmers
	Water supply / availability	• Availability of water by basin • Historical water levels in Tana and Athi Rivers • Trends in Water demand • Irrigation potential	• Some in SOE • MoA • County Integrated Development Plans (CIDPs) • National Irrigation Board (NIB) documents
	Water quality	• BOD • COD	• NEMA reports • State of Environment Reports • Farmers, who can comment on the quality of the nearby water sources
	Flood Risk	• Existing dams	• Kenya Electricity Generating Company documents • Websites, including www.nib.or.ke.
Air & Climate	Air quality	• Particulates	• NEMA reports • Villages / farmers who comment on dust or particulates in the air, and air pollution sources
	Climate Variability	• Average annual rainfall; • Other climate data	• Some in SOE • MoENR Climate Action program • County Integrated Development Plans (CIDPs)

Table 1. 4: Socio-economic data sources

Social		Data type	Source
Social cultural	Food & nutrition security	• Data on what typical households actually eat	• Farmers; • Existing studies.
	Health (AIDS & malaria etc)	• Available trends: • HIV/AIDS; • Cholera outbreaks; • Infant mortality	• SOE • Available statistics • Farmers • Expert Stakeholders
	Gender & Children	• Gender division of work and access to resources	• Existing studies • Farmers • Expert Stakeholders
	Governance, equity, and capacity	• Farmer training and Worker training	• Existing studies • Farmers • Expert Stakeholders
	Poverty & Income	• Population trends, socio-cultural practices, & beliefs (of farmers producers) Access to services (e.g., clean water) and how people access other services • Actual income associated with agricultural activities	• Some in SOE & DEAP World Bank Poverty Analysis; • 2009 Census • Kenya National Bureau of Statistics (KNBS) • Welfare monitoring surveys • County Integrated Development Plans (CIDPs)
	Livelihoods	• Description of villages and farms (and livelihood activities and employment statistics)	• 2009 Census • County Integrated Development Plans (CIDPs) • Existing studies Farmers
	Irrigation farming	• Trend data: on irrigation farming within the two basins • Barriers to adopting irrigation farming	• National Irrigation Board documents • Tana and Athi River Development Authority (TARDA) documents • Interviews • County Integrated Development Plans (CIDPs)
	Agricultural Economic development	• General economic development statistics	• KNBS • MoA • Farmers

			• County Integrated Development Plans (CIDPs)
	Economic development (trends in main sectors, including tourism)	• Economic activities and contribution to GDP	• KNBS • Ministries • Existing studies • County Integrated Development Plans (CIDPs)

Table 1. 5: Institutional data sources

Institutional Data type	Source
Planning capacity, coordination,	Existing documents & stakeholder interviews
Research (capacity for applied relevant research and dissemination of research)	Existing documents & stakeholder interviews
WRUAs organization (capacity)	Existing documents & stakeholder interviews
Enforcement of legal framework	Existing documents & stakeholder interviews
Monitoring and Evaluation Systems	Existing systems (or systems under development)

1.3.4.3 Identification of stakeholders

Effective and sustained public engagement is vital for SEA process. The main stakeholders and the information to be sourced from them were identified during screening and scoping stages of the study. The identified stakeholders were then involved in the stakeholder workshops undertaken as part of institutional and community consultations.

Plate 1: Stakeholder consultative forum at Mwea Irrigation Scheme offices

1.3.4.4 Literature review

This is an indirect method of data gathering and published data both in the Internet and from physical sources were collected. Both quantitative and statistical information from relevant secondary sources including various documents and reports on Tana and Athi River basins were collected and analysed. This helped in the identification of the gaps existing in the available information and enabled the SEA team to arrange to undertake detailed field investigations. Key documents reviewed included during the study include the following:

- National Guidelines for Strategic Environmental Assessment in Kenya (Feb.2011)
- Working Paper on Sustainable Natural Resource Management (2011)
- Millennium Development Goals (2005)
- County Integrated Development Plans (CIDPs) for all counties within Tana and Athi river basins
- Kenya Laws, Regulations and Policies:
- UNDP Climate Change Country Profile
- An Assessment of the Response to the 2008-2009 Drought in Kenya
- Climate change in Kenya;

1.3.4.5 Collection of baseline data

The SEA exercise collected comprehensive baseline data and undertook a situational analysis of the project area. The data looked at the whole ecological structure and functions with a view of making it sustainable. Social issues, especially those affecting livelihoods were also covered in the baseline data collection.

1.3.4.6 Analysis of alternatives

The SEA study identified project alternatives as part of planning stage activities. Alternatives considered included strategies, types of interventions, technologies, alignments, and project activities. The 'no-project' option was also considered.

1.3.4.7 Identification of impacts and their mitigation/enhancement

The SEA study focused on programme significant impacts, both positive and negative, with a view of mitigating the adverse ones and enhancing the positive ones.

1.3.4.8 Criteria for the Assessment and methods of data analysis

The main criteria used for the assessment during SEA study was the significance of potentially negative impacts and coming up with mitigative measures for adverse impacts and enhancement strategies for opportunities. The thrust was to come up with win-win situations. The assessment mainly used expert judgments, stakeholder inputs and NEMA's requirements in undertaking the assessment.

1.3.4.9 Recommendations

The SEA process has come up with recommendations for sustainable implementation of National Economic Programme and Expanded Irrigation Programme. These recommendations are contained in various chapters of this report and in the section on Environmental and Social Management Plan (ESMP)

1.3.4.10 Developing an Environmental and Social Management Framework (ESMF) and Monitoring Plan

The ESMP and ESMF both contain Environmental and Social Screening and Assessment Procedures, and a Monitoring Plan (MP). Mitigation Plans are included in the ESMF for the various interventions. The ESMP and ESMF are designed to ensure that any potential adverse environmental or social impacts are identified and that appropriate prevention and/or mitigation measures are properly undertaken during implementation of the programmes.

CHAPTER 2

2.0 DESCRIPTION OF THE PROPOSED PROGRAMS

2.1 Objectives, purpose, and rationale

The objectives, purpose and rationale of the programmes are as discussed below.

2.1.1 Objectives of the Pogrammes

The objectives of the NIB's programmes include the following:

(i) To accelerate irrigation expansion and development;
(ii) To improve performance of irrigation and drainage infrastructure within programme area through rehabilitation;
(iii) To improve provision of operation and maintenance services and increasing efficiency in water utilization;
(iv) To strengthen capacity of farmers and farmer organizations for management of irrigation systems;
(v) To improve land tenure systems;
(vi) To improve financial sustainability of public irrigation schemes; and
(vii) To improve agricultural and land productivity in irrigation schemes.

2.1.2 Purpose of the programmes

The Government of Kenya (GOK) is under obligation to ensure achievement of local and economic development through investments in rehabilitation and development of infrastructure in the area of irrigated agriculture. This will enhance food security and establishment of agro based industries for the benefit of communities in targeted areas. Drawing from this scenario, the government initiated the expanded irrigation and expansion of area under irrigation. Taking into consideration the diversity of the targeted areas and the variety of the beneficiaries, the Expanded Irrigation Programme (EIP) was classified into sub programs which reflect various components under the programme. The sub programmes under EIP indicate the area targeted for expansion, the budgetary allocation and the number of targeted beneficiaries under each classification.

2.1.3 Rationale of the programmes

Kenya has a total land area of 58.26 million hectares, out of which only 9.32 million hectares (16%) receive medium to high rainfall (800-1200mm per year), while the rest is arid and semi-arid (receiving below 800 mm of rainfall per year). Out of the total area in medium to high rainfall areas, approximately 7 million hectares is used for agricultural production and the programmes will accelerate food production through provision of irrigation water in arid and semi arid areas.

Agriculture is an important tool and vehicle for the realization of the Vision 2030 objectives of creating employment and reducing poverty. Agricultural sector is the backbone of the national economy contributing directly 24% of Gross Domestic Product (GDP) and 65% of the export earnings. In addition, agriculture

provides the livelihood of over 80% of the Kenyan population and their food security, (Agricultural Sector Development Strategy, 2009-2020). Agricultural growth and development, therefore, is crucial for Kenya's overall economic and social development. Further, the sector provides 75% of the country's industrial raw materials, and employs over 80% of Kenya's workforce. Its share of formal employment has increased from 18% in 2003 to 19% in 2009.

Kenya has an estimated irrigation potential of 540,000 hectares (based on surface water availability) out of which an estimated 119,200 hectares have been developed (Irrigation and Drainage Department- IDD, 2009). The National Irrigation and Drainage policy (2009) estimates that with storage of flood flow along rivers and streams, the irrigation potential can be increased to approximately 1.3 million hectares. During the last three decades, the rate of irrigation development in the country has been slow, with expansion of new irrigated/drained area attaining about 5,000 ha per year, which is equivalent to a growth rate of less than 5 (ibid). With this low rate of development (<5% per annum), it would take a staggering 84 years to exploit the approximate 540,000 hectares potential. This is worsened by the fact that rainfall endowment within the country in terms of volume, distribution and reliability, is poor. Irrigation development thus has a big role to play if the agriculture sector has to develop. It is as a result of this awareness that the Government of Kenya has set a target of expanding irrigation development by 40,000 hectares annually. The realization of this target will depend on, among other things, elaborate planning of irrigation development to aid in timely mobilization of the necessary resources, especially finances.

2.2 Alternative options and strategies

NIB has pursued a number of options and strategies in order to execute its mandate and ensure that its plans, projects and programmes are implemented in a way that benefits local people and ensures environmental sustainability. The options and strategies include the following.

2.2.1 Irrigation Expansion and development

The journey towards irrigation development and expansion is marked by studies as to feasibility or otherwise of the venture, actual expansion of the target area in case of new projects while rehabilitation of infrastructure in case of projects being revived. Collectively, the development is categorised into large, medium or small irrigation depending on the scope of land coverage. Irrigation potential in the country is estimated at 890,000 ha but only 154,800ha have been developed (NIB 2013). There is therefore need to exploit the potential through expansion of area under irrigation. NIB has therefore undertaken to conduct increased number of feasibility studies to determine the viability of irrigation projects in various parts of the country. Specifically, the feasibility studies target development of new irrigation projects in strategic locations in view of irrigational potential in the particular area. NIB has also been undertaking expansion of area under irrigation. The expansion is mostly implemented through development of new irrigation infrastructure. The expansion is based on need and irrigation locations are picked on the basis of need in compliance with set criteria for irrigation expansion. Rehabilitation component of irrigation projects is carried out on existing irrigation and drainage infrastructure in order to improve the performance of the infrastructure. This is with regard to ensuring efficiency in the conveyance, control and management of irrigation water

2.2.2 Water management under scarcity

The improvement of irrigated agriculture productivity is influenced by availability of adequate irrigation water supply. The Board has noted that due the erratic rainfall patterns in various parts of the country, crop production cannot be sustained. During the rainy seasons, crop production thrives due to availability of adequate water for irrigation. However, when the rain stops, or delay, the level of water in the rivers reduce affecting the quantity of water supplied to the farms. It has been observed that during the rainy season, a lot of water get wasted as floods and should be harvested and stored and used in irrigation during the dry season for crop production. In order to ensure sustainability in crop production, it is equally necessary that rain water be harvested and stored in storage dams. The Board has noted that construction of the water storage dams will improve water availability for irrigation purposes and for domestic use. This is specifically necessary in areas experiencing water scarcity, particularly arid and semi arid lands. NIB is targeting to construct one dam for every irrigation project.

2.2.3 Modernisation, Optimisation and Maximisation

In order to improve agricultural productivity, the focus must be in enhancing irrigation modernisation, optimisation and maximisation. Modernisation must be viewed in light of embracing and adoption of innovative concepts as well as technologies into irrigation. Optimisation must be considered in terms of application of best practices towards utilisation of limited developed irrigation space and scarce water to realise better crop production. Maximisation must in its conventional context be viewed as putting more and more land under crop production through well thought of strategies and mechanisms. The Board has initiated the modernisation process of projects by adopting modern irrigation technologies that are geared towards increasing water use efficiency and optimizing irrigation production through precision farming. The modernisation initiatives have benefited Kibwezi clusters irrigation development project where the installation of drip irrigation system has resulted into production of 800 acres using the same volume of water that was initially applied to 391 acres under the traditional furrow irrigation system (NIB Strategic Plan 2013-2017). Other initiatives include installation of centre pivots for 1000 acres in Bura.

2.2.4 Legislative, Institutional and operational capacity

The area captures delivery of irrigation services in the devolved system of government in accordance with the provisions of the Constitution of Kenya 2010. The new constitution has created two levels of government at national and county levels. This has transferred national government administrative organs to county governments through devolved system of governance. NIB is expected to provide irrigation services at the County levels. Under the new constitutional dispensation, it will be necessary for the operational structures of NIB to be adjusted so as to make it responsive to the demand of constitution on service delivery at County levels. NIB is in the process of establishing an Irrigation Services Department (ISD) at the Head Office and Regional Irrigation Services Offices (RISO) within the selected regions in order to align their operations with the new constitution. The Regional Irrigation Service Office will be responsible for coordination of service delivery in the irrigation projects.

2.3 Areas and sectors affected by programme activities

2.3.1 Areas affected by programme activities

This SEA covers Tana and Athi River basins. The Tana River Basin is one of the most important drainage basins in the country and consists of the Tana River, which is the largest river in Kenya, and its tributaries stretching over a total length of 1,000km. The main part of the catchment comprises the Mt. Kenya and the Aberdares in Central Kenya, with an area of about 95,000 km^2, which is approximately 17 % of Kenya's landmass (Agricom Consultants Ltd 2011: p.21). The catchment covers parts of Central, Eastern, North Eastern and Coast provinces. Tana River flows for most of its course across semi-arid and arid regions, while meandering through an alluvial flood plain of varying width from 2 km in the middle to 42 km in the lower delta areas. The river forms the Tana Delta, which is the largest deltaic ecosystem in Kenya, stretching over 180,000km^2 before entering the Indian Ocean through Kipini.

The Athi River Basin on the other hand is approximately 67,000 Km^2 and comprises the southern part of the country east of the Rift Valley. The basin drains into the Indian Ocean via major rivers such as the Athi River, Voi River, Kwale River, Vanga River and the Umba River (Agricom Consultants 2011: p.21). Athi Basin drains an area that is very active and with high potential in terms of agricultural and industrial enterprises. The Basin is also home to Kenya's capital City, Nairobi, which draws a lot of its domestic water from the Athi Basin. The primary sources of water for the Athi River originate from the Ondiri springs, Tigoni falls, the Kikuyu escarpment and the Kabete and Karura forests. The tributaries to Athi River that drain the upper Athi catchment include Koma, Ndaragu, Ruiru, Ruaraka, Mathare, Mutoine, Mbagathi, Ngong and Nairobi Rivers. These tributaries join the Athi before its confluence with Thwake River. Downstream of the Thwake confluence, the Athi River drains large areas characterized by arid and semi-arid conditions, with predominantly seasonal rivers or streams and very few perennial streams that include the Tsavo, Tiva and Sabaki Rivers, before draining the water into the Indian Ocean north of Malindi Town.

The areas to be affected by programme activities are those that are drained by Athi and Tana Rivers and their tributaries and include nineteen counties in total. The Counties of Tana River basin include Nyeri, Muranga, Embu, Meru Tharaka Nithi, Kirinyaga, Kitui, Tana River, Garissa and Lamu while Counties under Athi River basin include Kiambu, Nairobi, Machakos, Makueni, Kajiado, Taita Taveta, Mombasa, Kwale and Kilifi. The figure below shows map of the project area.

2.3.2 Sectors affected by programme activities

Based on the objectives of the NEP and EIP, it is important to note that a number of sectors will be affected by programme activities. Looked at in perspective, implementation of programme activities are likely to lead to various impacts in a number of sectors including agriculture, water, forestry, public health and wildlife as explained below.

2.3.2.1 Agricultural sector

Adoption of irrigated agriculture will result in intensification of agricultural activities within the targeted areas. Intensification of agriculture is likely to result in the intensification of problems from pests and

diseases. Improved wet season drainage is likely to create more favourable conditions for cutworm larval survival (reductions in extent and duration of soil flooding, which can drive cutworms to the surface where they may be killed by exposure or predated). More importantly, the intensified cropping systems will rely on improved crop varieties which tend to require agrochemical inputs to reach their yield potentials. Widespread use of agrochemicals will contribute to a reduction in overall crop varietal diversity, therefore increasing the risk of pest and disease outbreaks.

2.3.2.2 Water Sector

During operation phase, the projects under the programmes will require large volumes of water from nearby water sources. There is therefore likelihood of significant competition for water resources within the basin and this may call for putting in place water conservation and management measures to ensure that the available water resource can meet competing uses. Increased use of pesticides especially as a result of implementation of the projects under the programmes may also lead to water pollution from agrochemicals and pesticides.

2.3.2.3 Public Health Sector

Implementation of projects under the programmes will intensify problems from crop pests and diseases and this will call the use of pesticides. Uncontrolled and inappropriate use of pesticides is likely to increase significantly, with significant adverse impacts on exposed workers, residents, wildlife and ecosystems. Agricultural intensification will alter this picture, creating both a demand for better pest and disease control and the funds to purchase pesticides. If unmanaged, this process is highly likely to result in the same adverse impacts on human and environmental health experienced in many other locations worldwide under similar circumstances.

2.3.2.4 Wildlife Sector

Implementation of projects under the programmes will involve vegetation clearance within project alignment area leading to destruction of forestry resources which are wildlife habitats. Construction of the works will reduce available feeding and breeding habitat for local fauna, and will affect access to vegetative resources within the project alignment area. Cases of human-wildlife conflicts may increase within the programme areas.

2.3.2.5 Forestry Sector

Implementation of projects under the programme will involve vegetation clearance within project alignment areas. This may lead to destruction of forestry resources. A case in point is Galana-Kulalu Food Security Project under National Economic Programme.

2.4 Components and activities of the programmes

2.4.1The National Economic Programme (NEP)

2.4.1.1 General

Under this programme is the Galana/Kulalu Food Security Project where the government targets to put 1 million acres in Galana/Kulalu ranch under irrigation by 2017. The ranch which covers an area of 1.78 million acres is strategically located between Rivers Galana and Tana which are believed to have adequate flow to supply irrigation water. When appropriately developed, the ranch has the potential of being a major contributor to the nation's economy, provide jobs (directly and indirectly) for millions of people and trigger a multiplier effect on local commerce, industry and services as envisaged in the Kenya's Vision 2030.

2.4.1.2 Components of Galana/Kulalu Food Security Project (GKFSP)

The table below gives a summary of the main components of Galana/Kulalu Food Security Project.

Table 2. 1: Components/enterprises under Galana/Kulalu Food Security Project

Component/ Enterprise	Description	Area (Acres) allocated
Maize	The Proposed project will put 475,253 acres in one block and 50,000 acres on the pilot/model farm totaling 525,253 acres under irrigated maize production. The maize will be rotated with other crops i.e. beans, sorghum, among others. Maize irrigation blocks have been subdivided into roughly 40 blocks of 5000 ha (12,500 acres) inclusive of a camp and machinery yard.	525,253
Sugar Cane	There will be a 281,731 acres sugarcane block and an additional 30,000 acres on the pilot farm or in total 311,731 acres under sugarcane farming. The planned sugarcane irrigation blocks have been subdivided into roughly 24 blocks of 5000ha (12, 500 acres) inclusive of a camp and machinery yard.	311,731
Fruit / Orchard	A main block of 84,143 acres and an additional 5000 acres on the pilot farm are earmarked for fruits production making a total of 134, 143 acres for the enterprise.	134, 143
Vegetable	A main block of 37,529 acres and another 15,000 acres on the pilot farm totaling 52,529 acres are earmarked for this activity.	52,529
Dairy Production	A main block 99,116 acre and another 10, 000 acres on the pilot farm are set aside. In total, 109,116 acres are earmarked for dairy farming.	109, 116
Game and Beef Ranching	A total of 169, 282 acres are earmarked for game and beef ranching enterprise and another 126,470 acres bordering Tsavo National Reserve will act as a (Buffer) transition zone from the National park and other farming activities. This totals 295,752 acres.	295,752
Goat and Sheep	The production of sheep and goat will be integrated in the area zoned ranching adjacent to the Tsavo East National Park.	-
Poultry and Fisheries	Poultry rearing enterprises will be integrated in areas zoned for dairy and horticulture	-

Tourism Development	Within the Urban Development Model (zone 28), a modern resort is proposed. The resort will be designed to include sports facilities such us golf and holiday homes. The existing tourism facilities (camps and resorts) will also be integrated especially within the game and beef ranching production areas.	-
Human Settlements Zone	It is anticipated that a population of approximately two (2) million people will be employed directly and indirectly by the project. The principle of urban hierarchy which can be derived from population and services offered within the urban settlement, suggests the project area will grow tremendously and there is a need to develop an urban settlement within the project area to offer various services.	-
Proposed New Town	The proposed urban area in Galana-Kulalu is expected to be large. A total of 117,805 acres are reserved for urban development with the largest block taking up to 63,500 acres from which a layout plan has been made and the other two with 23,722 acres and 31,570 acres being reserved as land banks for future urban development.	117,805
Storage dam	The objective of the storage dam is to control the river flow in order to provide irrigation water, to gain flood control and assure domestic water supply.	2,000,000 m^3

2.4.2 The Expanded Irrigation Programme (EIP)

2.4.2.1 Introduction

Expanded Irrigation Programme aims to attain National Food Security in Kenya by eliminating hunger amongst Kenyans through acceleration of coverage of the 1.7 million acres potential irrigation land in the country which will ultimately make Kenya a net exporter of food. The programme aims to develop 540, 000 ha of land for irrigation in 5 major river basins, among them Tana and Athi river basins in order to improve sustainability in agriculture and production through irrigation. This will in turn increase food security by expansion of areas under irrigation which will in the long run enhance income levels of the farmers and raise living standards of about 1,525,400 households within the targeted areas

2.4.2.2 Programme Initiatives

The programme initiatives form the basis of categorization of the various approaches proposed for undertaking EIP. The classification of the programme initiatives into sub programmes clearly brings out the targeted categories and components under focus in the EIP which includes progress initiatives, start-up initiatives, affirmative initiatives, design initiatives and capacity initiatives. The table below gives a summary of the initiatives.

Table 2. 2: Categorization of approaches to project implementation under EIP

No	Initiatives	Explanation	Acres to be brought under irrigation	Households to benefit
1	Progress Initiatives	Focuses on the completion of ongoing projects countrywide.	48 600	610,000
2	Start- Up Initiatives	Targets new irrigation projects.	18700 (2011/12) 700 (2012/13)	319,000
		Additional funding has been invested in developing irrigation projects in other areas to ensure regional equity.	49,250	174,500
3	Affirmative Initiatives	These are efforts of developing irrigation projects in the northern part of Kenya in order to establish a sustainable source of livelihood for the inhabitants in the dry areas.	5575	334,000
4	Design Initiatives	The focus here is to speed up the completion of irrigation designs in strategic areas of the country including Kalemunyang, Nakamane, Morulem, Naoros and Napak. More funds have been set aside for completion of designs for irrigation projects countrywide. Funds will also be set aside for settlement of local residents currently occupying the targeted 1200 acres proposed for the expansion of Mwea Irrigation Scheme.	85000	375,000
5	Capacity Initiatives	Due to the demand of expanded irrigation programme, NIB will need to enhance its human resource, technical competence and financial management capacity. This will ensure effective management of the project implementation and the increased financial capital associated with the programme.	-	-

2.5 Irrigation development and expansion under Expanded Irrigation Programme

Irrigation development and its expansion in Kenya are driven by the demand to attain domestic food security and exploit opportunities for agricultural exports. The irrigation development and expansion equally targets production of agro-based raw materials for industrial development. The Kenya aspects of irrigation and its expansion are put into perspective in the Kenya Vision 2030 (KV2030). In its microeconomic strategy for long term development, KV2030 incorporated rehabilitation and expansion of infrastructure as a key pillar (pillar two) which focuses on equity and wealth creation. The measures to be taken for anti-poverty and inequality interventions included increase in resource allocation for priority areas of agriculture and rural development. In a nutshell, irrigation increases agricultural productivity in both high potential and arid areas, allows increase in irrigable area using all the available surface and ground water resources, provides raw materials for industries thus creates employment, enhances food security and it is an avenue for wealth creation for rural communities. Starting with the theme on continuity, the on-going programmes and projects can and are hereafter further refined into sub-groups that have more to do with the future in consideration.

2.5.1 Large scale basin based irrigation projects

In adopting this approach, the Board has completed design for large scale basin projects covering a total of 373,00ha. Going by their magnitude, such projects are designed for implementation in periods over the five years plan period and beyond with a big part done within the 2013-2017 plan cycle. Such projects will have a huge impact on the economic achievements under the KV2030. During the 2nd horizon Mid Term Plan (MTP), a total of 47,000ha will be targeted for development. The targeted projects within Tana and Athi River Basins are listed below.

Table 2. 3: Large scale basin based irrigation projects within Tana and Athi River basins

No	Project name	County	Basin	Target area ha	Target Area under 2nd MTP ha	Status	Estimated Cost M Kshs
1	Greater Bura Irrigation Project	Tana River and Garissa	Tana	240,000	20,000	Design ongoing construction for 6500ha to commence in 2013	13,920.00
2	Greater Kibwezi Irrigation Project	Makueni and Kitui	Athi	42,000	5,000	Design ongoing construction of 320ha of drip irrigation project is complete	3,400.00
3	Rahole Canal Irrigation Project	Garissa	Tana River	5,000	5,000	Design for irrigation infrastructure ongoing	3,000.00

						-construction of 200ha ongoing under small holder	
	Total			287,000.00	30,000.00		20,320.00

Greater Bura irrigation and Greater Kibwezi irrigation projects are flagged on account of the modernization components.

2.5.2 Large Scale River based irrigation projects

In adopting this approach, the Board has completed design for large scale project covering a total of 133,750ha. These projects due to their magnitude will be implemented during the five year plan period. The projects are as listed below:

Table 2. 4: Large scale River irrigation projects within Tana and Athi River basins

No	County	Project name	Target area ha	Target area under 2nd MTP ha	status	Estimates cost Kshs (M)
1	Mwea Irrigation Development Project	Kirinyaga	16,000	5,000	• Construction for Thiba dam and irrigation infrastructure of additional 2000ha to commence in 2013	2,000
2	Kavunyalalo Irrigation Project	Kilifi	10,000	3,750	• Design ongoing	1,500
3	Mitunguu Irrigation Development Project	Meru Tharaka Nithi	10,000	8,000	• Design for irrigation infrastructure complete	3,200
4	Rwabura Irrigation Development Project	Kiambu	10,000	2200	• Design for irrigation infrastructure complete	1,200
5	Kaagari Gaturi Irrigation Scheme	Embu	6,600	3,000	• Design for irrigation infrastructure complete • Construction of 1000 ha ongoing.	1,400
6	Hola Irrigation	Tana River	3,500	3,500	• 1,400ha under	5,000

	Scheme				operation • Design for irrigation infrastructure for 3,500ha complete	
7	Kayatta Irrigation Development Project	Machakos	2,000	2,000	• Design ongoing	1,200
8	Usueni Irrigation Development Project	Kitui	2,000	2,000	• Design for irrigation infrastructure ongoing • Construction of 200ha under small holder.	1,200
9	Kieni Irrigation Development project	Nyeri	2,000	2,000	• Design ongoing	800
10	Muringa Banana Irrigation Project	Tharaka Nithi	5,000	3750	• Design for irrigation infrastructure complete • Construction of 100ha ongoing.	1,500
	Grand Total		67,100	35,200		19,000

2.5.3 Small holder irrigation projects

These are schemes that are initiated by the communities with an aim of boosting their agricultural production. The small holder schemes have been developed in Kenya through initiatives from government (MWI, MOA) donors, NGO's and funds raised by communities. In terms of size, the schemes ranges from 50ha to 200ha with structures that are fairly small making them easy to build, operate and maintain. The major irrigation structures, water supply and distribution systems are operated and maintained by Water Undertakers. The Water Users Association (WUAs) have full responsibility for water supply, distribution and the accompanying operation and maintenance activities, and schemes or farms where individual farmers are the investors and operators and the land holdings receiving water are small therefore benefiting large populations. The projects are quick wins in irrigation development because the implementation cycle is short from identification design and construction taking one year to complete, they can also be implemented in regions with fairly limited water resource, can use different water source including major rivers, streams , water pans and boreholes. These projects are therefore well distributed in the country. The Board has earmarked 47,000ha of projects listed in the table below for implementation during the 2013-2017 medium term periods. The projects under this category that are located within Athi and Tana River basins are listed in the table below:

Table 2. 5: Small holder irrigation projects within Tana and Athi River basins

No.	Project Name	County	Target Area Ha	Amount Ksh M
1	Gachoka clusters irrigation scheme	Embu	100	70
2	Kiambindu irrigation scheme	Embu	150	105
3	Holwadag irrigation scheme	Garissa	200	140
4	Kulan dam irrigation project	Garissa	50	35
5	Alloley irrigation project	Garissa	100	70
6	Isinet irrigation project	Kajiado	300	210
7	Olkaria irrigation project	Kajiado	150	105
8	Entarara irrigation scheme	Kajiado	300	210
9	Kimana irrigation project	kajiado	300	210
10	Matepes irrigation project	Kajiado	200	140
11	Kamuka irrigation project	Kiambu	150	105
12	Burangi irrigation scheme	Kilifi	2000	1400
13	Lustangani irrigation project	Kilifi	2000	1400
14	Kitui cluster irrigation project	Kitui	200	140
15	Thaana nzau irrigation scheme	Kitui	1000	700
16	Mui-thua green valley irrigation project	Kitui	1000	700
17	Kiangai irrigation project	Kirinyaga	100	70
18	Gachoka clusters irrigation scheme	Kirinyaga	300	210
19	Kii/Njoga irrigation scheme	Kirinyaga	300	210
20	Mitoo-ini irrigation project- Kirinyaga south	Kirinyaga	500	350
21	Mwache irrigation development project	Kwale	150	105
22	Kinango water harvesting project	Kwale	50	35
23	Mwangea irrigation project	Kwale	1000	700
24	Machame irrigation project	Kwale	100	70
25	Iraru irrigation scheme	Meru	150	105
26	Marega irrigation scheme	Meru	100	70
27	Kimachia irrigation scheme	Meru	200	140
28	Ugoti marega irrigation scheme	Meru	150	105
29	Kunati irrigation project	Meru	200	140
30	Kinanduba irrigation scheme	Meru	120	84
31	Miu/Kitathani irrigation project	Machakos	270	189
32	Kamuthabaya irrigation project	Machakos	200	140
33	Mutuyu/Kayatta b irrigation project	Machakos	150	105
34	Machakos clusters irrigation project	Machakos	200	140
35	Kwamathathi irrigation project	Machakos	200	140
36	Iviani irrigation project	Makueni	200	140
37	Kwa majee irrigation project	Makueni	50	35
38	Kiboko irrigation project	Makueni	100	70
39	Kakusi irrigation scheme	Makueni	150	105
40	Makuku irrigation scheme	Makueni	150	105
41	Kambi yam awe dam irrigation scheme	Makueni	150	105
42	Kyeni Kia Musi irrigation scheme	Makueni	150	105

43	Utangwa irrigation project	Makueni	150	105
44	Yikitaa irrigation project	Makueni	150	105
45	Kanyai Nthongoni irrigation project	Makueni	150	105
46	Nyanjigi irrigation project	Murang'a	400	280
47	Mirichu-Murika irrigation project	Murang'a	400	280
48	Irati irrigation scheme	Murang'a	2000	1400
49	Rimukurwe irrigation project	Nyeri	400	280
50	Ndirithi Aguthi	Nyeri	200	140
51	Hika irrigation project	Nyeri	1000	700
52	Njukini irrigation project	Taita Taveta	150	105
53	Rwatha Krethani and Baragu	Tharaka Nithi	350	245
54	Tunyai Gakurungu irrigation project	Tharaka Nithi	300	224
55	Siakariga irrigation project	Tharaka Nithi	500	350
	Grand Total		20,090	13,657

2.6 Irrigation water storage reservoirs

The primary resources for irrigation development are land and water, whereas land is a fixed resource, water is varying resource. In recent years the water resources have been shrinking, a factor that has been attributed to climate change and other human activities hence less water is available for irrigation. To stabilize the availability of irrigation water, it is important to develop water storage reservoirs to store excess waters for use during the dry spells. The Board has initiated studies for a number of dams for various irrigation projects and proposes to undertake more studies in a bid to have a dam for each irrigation project. The dam projects located within Athi and Tana River basins proposed are as per table below:

Table 2. 6: Water storage projects to be implemented

Proposed Dam	Project Name	County	Source of water	Status	Estimated volume Million cubic meters	Estimated Cost Ksh M
Thwake Dam	Greater Kibwezi irrigation project	Makueni county	R.Athi	-Design ongoing	50	5,900
Thiririka Dam	Rwambura irrigation scheme	Kiambu County	R.Thiririka	-Design ongoing	11	1,171
Rwambura Dam	Rwambura irrigation scheme	Kiambu County	R.Rwambura	-Design ongoing	15	1,297
Kithaakanaaro Dam	Mitunguu Irrigation Development Project	Meru County	R.Kithino	-Proposed	52	4,535
Gatuatine Dam		Meru County	R.Thingithu	-Proposed	4	426
Kagwampungu		Meru County	R.Thingithu	-Proposed	5	700

Mariba Dam		Meru County	R.Thingithu	-Proposed	7	900
Kora Dam	Greater Bura Irrigation Project	Tana River Garissa	R.Tana	-Proposed	50	4,322
Maara Dam	Muringa Banana Scheme	Tharaka Nithi	R.Maara	-Proposed	19	1,420
Karemenu Dam	Kieni Irrigation Scheme	Nyeri County	R.Ewaso Ngiro	-Proposed	18	1,316
Ngare Ngiro Dam		Nyeri County	R.Ngaro Ngiro	-Proposed	39	3,150
Chania Dam		Nyeri County	R.Chania	-Proposed	24	1,554
Waiwa		Nyeri County	R.Amboni	-Proposed	5.5	880
Tinga I		Nyeri County	R.Nanyuki	-Proposed	2	540
Naromoru		Nyeri County	R.Naromoru	-Proposed	10.6	1,171
Kamburaini		Nyeri County	R.Nairobi	-Proposed	3.5	678
Grand total					315.6	29,960

Table 2. 7: Implementation framework

Projects/programmes	Activities	Targets	Financial Years (FY) Milestones				
			2013/ 2014	2014/ 2015	2015/ 2016	2016/ 2017	2017 / 2018
Increasing Feasibility studies	Conducting feasibility studies for new projects	20 feasibility studies	4	6	5	3	2
	Undertaking review of existing feasibility studies	30 reviewed feasibility studies	6	10	8	4	2
Increasing detailed designs	Undertaking more detailed designs of viable irrigation projects	50 detailed designs	10	16	13	7	4
Expansion of more areas under irrigation	Construction of irrigation infrastructure to expand area under irrigation	89,900ha	17,800	35,600	26,700	6,500	3,300
Rehabilitation of additional irrigation and drainage infrastructure	Undertaking desilting of canals/drains, lining of canal, repair of gates, grading of roads and maintenance of pumps/pump house	128 projects	25	40	35	20	8
Construction of water storage dams in all projects	Construction of water dams for improved irrigation water storage	128 dams	30	40	35	15	18
Promoting adoption of Modern Irrigation Technology (MIT)	Investigating in modern irrigation technology for enhancing water use efficiency and agricultural productivity	128 Modern Irrigation Systems	28	37	32	25	6
Improving Capacity Building of farmers and farmer organizations	Training programme in crop husbandry, water use efficiency and Irrigation Project Management	64,0000 farmers	12,800	22,400	18,600	8,600	2,000
		128 farmer organizations	25	40	35	15	13
Enhancing Provision of Input Supply and credit facilities for more farmers	Linking farmers to strategic partners for input supply and credit facilities	64,000farmers	12,800	22,400	18,200	8,600	2,000
Promoting Agricultural Mechanization for crop	Investing in agricultural mechanization for crop production	128 agricultural machinery/equipment	28	40	33	17	10

Production							
Consolidating land in schemes to facilitate mechanization	Implementing Land Consolidation programme to facilitate mechanization in large farms	500ha	1,000	1,800	1500	500	200
Linking additional farmers to more market outlets	Promoting marketing of farm produce by linking more farmers to additional market outlets	64,000 farmers	12,800	22,400	18,200	8,600	2,000
		10 additional market outlets	2	5	2	1	-
Establishing Research Stations and improving capacity of MIAD Research Centre	Establishing additional research stations and recruitment of research professionals	5 research stations	1	2	2	1	-
		Recruit 10 additional research professionals	2	4	3	1	-
Develop and implement awareness campaign programme on irrigation development	Conduct awareness campaign programmes to encourage public participation in irrigation development	5 awareness campaign programmes	1	2	2	-	-
Commercialization of farming	Establishment of large scale commercial farms in Bura & Tana irrigation schemes	2 larger commercial farms	2	-	-	-	-
Promoting adoption of Modern farming Technology	Establishing greenhouses in all project areas	1,000 green houses	200	400	250	100	50
Implementation of Irrigation services	Setting up Irrigation service Department & Regional Offices for delivery of irrigation services	Irrigation service Department & 7 Regional Offices	4 Regional offices	3 Regional offices	-	-	-

CHAPTER 3

3.0 DESCRIPTION OF BASELINE ENVIRONMENTAL CONDITIONS

3.1 Geographical Location

Tana River basin straddles across several Counties which include wholly Muranga, Kirinyaga, Embu, Tharaka - Nithi, Kitui, Tana River and Lamu as well as bigger parts, of Garissa, Meru, Nyeri, Machakos and smaller parts of Kiambu Kilifi and Nyandarua. The catchment area is within latitudes 0^0 30' North and 2^0 30' South and longitudes 37^0 00' East and 41^0 00' East. The basin extends from the top of Mt. Kenya, the Aberdares Ranges and the Nyambene Hills in the north, extending southwards to the Indian Ocean.

Athi Catchment is bound by latitudes 1^0 to 4.5^0 South and longitudes 36.5^0 to 40^0 East. It borders the Tana Catchment Area (TCA) in the north and east, Indian Ocean in the east, Tanzania in the south, and Rift Valley Catchment Area (RVCA) in the west. The Aberdare Range, one of the five water towers, lies in the northern edge of the area. Administratively, the drainage basin covers: Nairobi, Makueni, Taita Taveta, Kwale and Mombasa counties, a part of Kiambu, Machakos, Kajiado, Kilifi and small areas of Kitui County.

3.2 Physiographic and natural conditions

3.2.1 Topography

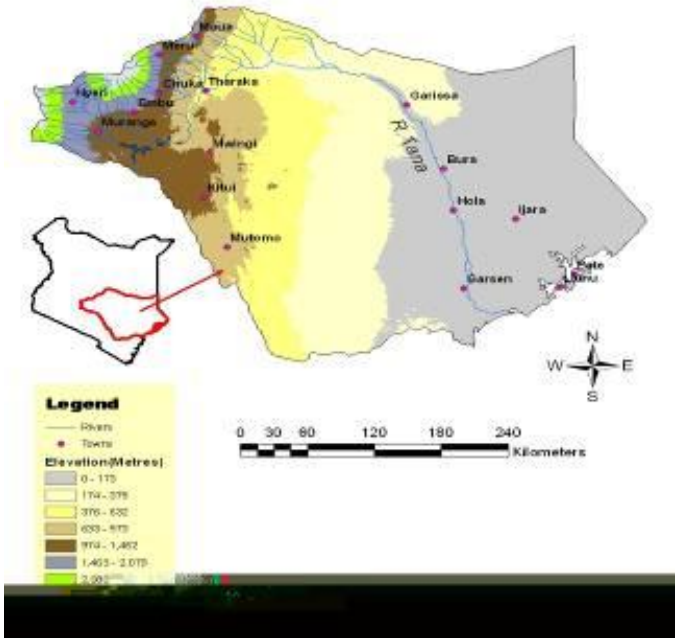
The topography of the project area varies from the foot of Mt. Kenya to the coastal areas of the Indian Ocean. The highlands in Tana basin include Mt. Kenya, Aberdares and Nyambene hills with other isolated hills (like Mumoni near Mwingi, Mutonguni / Mutito, Nuu, Endu near Kitui and Kiambere/ Kiang'ombe near Kiambere/ Siakago). There are isolated hills in the Athi Catchment which include the Ngong in the north western side of the catchment, Kangundo, Iveti, Mbooni, and Kilungu hills in the central region while Chulu and Taita Taveta hills are in the southern region. Shimba hills is along the coast in Kwale County. Athi catchment is characterized by plains like the Kapiti plains in the upper and middle area while Nyika plateau is in the lower areas. The highest altitude within the two basins is at Mt. Kenya peak of Batian which is just over 5,190 m above the sea level while the lowest is at sea level along the Indian Ocean.

The drainage of the Tana Catchment is through Tana River and its tributaries which form dendritic drainage system from the highlands. The rivers originating from Aberdares ranges, Mt Kenya and Nyambene hills are perennial while those originating from the isolated hills in Kitui and Mbeere areas are seasonal. Tana River is perennial with perennial tributaries which include Thika, Saba Saba, Maragua, Mathioya, Gura, Nairobi, Sagana, Ragati, and Rwamuthambi Rivers. Others include Thiba, Ena, Mutinga, Kathita, Ura and Rujiweru Rivers. The seasonal tributaries of Tana River include Tyaa, Tiva, Thua, Laga Kokani and Laga Tula. Lake Kenyatta is the only lake within the catchment and is along the Coast around Mpeketoni area. There are strategic springs around Kiang'ombe/ Kiambere hills, Mutitu hills, Nuu hills and Endau hills. In the middle zone are five hydro power stations which include Masinga, Kamburu, Gitaru, Kindaruma and Kiambere dams.

The drainage of the Athi Catchment is through Athi River and its tributaries which form the drainage system from the highlands. The rivers originating from Aberdares ranges, the Chulu and Taita Taveta hills are perennial while those originating from the isolated hills in Machakos (Iveti and Kangundo), Kajiado (Ngong) and Makueni, areas are seasonal with some stream being perennial near the sources. The coastal rivers are mostly small and perennial. Athi River is generally perennial with perennial tributaries which include Kamiti, Ruiru, Thiririka, Nairobi and Ndarugu from Aberdares; Lumi and Tsavo from Taita hills; and Kiboko, Makindu, Kibwezi and Mutitu Andei from the chulu hills which are drying due to catchment destructuin of the Chulu hills. The Rare, Mwache, Shimba, Ramisi, Umba Rivers are in the coastal zone and are generally perennial. The upper Athi and Mbagathi Rivers from Ngong and the Thwake and Kaiti from the Kangundo/ Iveti hills and Mbooni/ Kilungu hills respectively are seasonal.

There are many springs in Athi catchment with include Kikuyu springs in Kiambu; Umani in Makueni; Nolturesh in Loitoktok/ Kajiado; Mzima and Njoro Kubwa in Taita Taveta; and Marere in Kwale. Lake Amboseli in Kajiado and lakes Jipe and Challa in Taita Taveta are the lakes within the catchment and are around Mt Kilimanjaro area with Chala and Jipe being along Kenya -Tanzania boarder. The catchment has National Parks which include Tsavo, Amboseli and Simba hills National Parks.

Figure 3. 1: General relief features of Tana Catchment area



Source: Tana Catchment Management strategy

3.2.2 Agro Ecological zones

Tana and Athi catchment stretches from Mt. Kenya to the Indian Ocean. There are several agro-ecological zones where varied agricultural activities are practiced. The altitude of the catchment ranges from 0 m to 5190 m above sea level. The pattern of Agro-ecological zonation (AEZ) is typical, starting from Mr. Kenya with Tropical Alpine Zones (TA I and II) as shown in Table 3.1.

Table 3. 1: Agro-ecological zones within the programme area

AEZ	Zone	Characteristics and types crops and livestock reared
Tropical Alpine	TA 0, I, II	No land use, National Park, limited grazing
Upper Highland	UH 0, 1, 2, 3, 4	Very wet, important as catchment areas, bamboo thickets and forest reserves, pyrethrum, barley, oats, peas, radish, rapeseed, Irish potatoes, kohlrabi, celery, leeks, wheat, plums, pears, apples, pasture and forage, white clover, rye grass, grade dairy & beef cattle, merino sheep, 0.8 – 2ha/LU
Lower Highland	LH 0, 1, 2, 3, 4, 5	Forests, long cropping season, good crop yield for lettuces, tea, kales, peas, cabbage, carrots, Irish potatoes, pyrethrum, hybrid maize, leeks. Napier grass, clover and grade dairy cows, black wattle, kikuyu grass, apples, pears, plums, avocadoes, wheat, barley, Rhodes grass. White clover, 0.5 – 6ha/LU
Upper Midland zones	UM 1, 2, 3, 4, 5, 6	Coffee-tea and sunflower zone. Crops grown include; tea, coffee, Irish potatoes, tomatoes, cabbage, maize, bananas, beans, Sunflower, tobacco, sweet potatoes, citrus, mangoes, pawpaw, avocadoes, passion fruits, cassava, yams, sugar cane, miraa, Taro, fodder crops/legumes, 0.5 - 5ha/LU
Lower Midland zones	LM 3, 4, 5, 6	Cotton-livestock-millet zone. Crops grow include; cotton, dryland maize, sorghum, dolichos, ground nuts, tobacco, sweet potatoes, cassava, pineapples, cowpeas, chick peas, soya bean, pumpkins, green grams, mangoes, onions, castor, bulrush/ proso/finger millet, pigeon peas, macadamia nuts, Sisal, Leucaena leucocephala, bana grass, zebra grass, siratro, 0.8 – 4.5ha/LU
Lowland/inner lowland	L 5, 6	Livestock millet zone – short cropping season. Crops grow include; bulrush/proso millet, green grams, gourds, dryland composite maize, dwarf sorghum, sisal, castor, jojoba, cowpeas, bambara nuts, 2.5 – 5.5ha/LU, game ranching with oryx, gazelle and gerenuk
Coastal Lowland	CL 3, 4, 5, 6	Coconut-cassava zone: composite maize, white sorghum, finger millet, bulrush millet, foxtail millet, green grams, sunfl ower, groundnuts, lima beans, cucumber, garlic, water

		melons, bixa, pepper, chilies, sisal, cashew nuts, pineapples, bananas, lemons, ground nuts, cowpeas, cassava, okra, Indian avocados, pawpaws, bocoboco, Jatropha, rice, sugar cane, castor, sweet potatoes, bana grass, fodder legumes,maram beans, buffel grass, siratro, centro, Acacia albida, 0.2 – 5ha/LU, sclerophytic evergreen(infested with tse tse fly) bushland, seasonally flooded grasslands

Source: WRMA, 2009

3.3 Climate

3.3.1 Climate within Tana Basin

Rainfall within Tana basin varies with altitude with higher areas having more rain than the lower areas. The upper zone which comprises the towers (Mt. Kenya, Aberdare ranges and Nyambene hills) with an altitude of above 900m above sea level has rainfall which is above 800mm per year. The middle zone which covers the area between 300m to 900m has rainfall within the range of 400mm to 800mm per year while the lower zone of below 300m has rainfall which increases towards the ocean from 400mm to around 100mm per year. Table 3.2 below shows the monthly mean rainfall and rain days as per the stations considered.

It is clear that in most of the stations, there is a trend of generally dry periods during the months of June, July, August, September, January and February. The stations in upper zone registered high rainfall of over 100mm per year while the lower zone registered low rainfall of below 500mm per year except at the Lamu meteorological Station, whose conditions are influenced by the coastal climate. Embu and Meru have 5 months with over 100mm of rain while Nyeri, Sagana and Kitui have four months of the same category. Thika and Lamu have 3 months with over 100mm rainfall while Kindaruma and Marimanti have only 2 months with the same rainfall. Garissa and Hola have no months with 100mm of rain

In upper zone, the rainfall amount per month is enough to sustain the crops in some wet months. However, the crops will require supplementary irrigation during the dry periods. In the lower zone, most months do not have enough rainfall to sustain rain-fed agriculture hence need to supplement during most of the months which are dry for even the rain days are very few. As per the records, Nyeri and Embu have 6 months with more than 10 rain days while Sagana, Thika, Meru and Lamu have 4 months with more than 10 rain days. However, Kindaruma, Marimanti and Kitui have 2 months with at least 10 rain days while Garissa and Hola have no month with 10 rain days.

Table 3. 2: Monthly mean rainfall (mm) and rain days in considered meteorological stations

Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yearly Total
Nyeri Met. Station	103.0	68.0	91.0	93.0	213.0	41.0	20.0	31.0	19.0	120.0	152.0	72.0	1023.0
	8	7	11	14	16	6	6	7	4	10	14	10	113
Sagana Fish Farm	36.0	46.0	86.0	397.0	213.0	26.0	14.0	18.0	26.0	134.0	267.0	77.0	1340.0
	5	3	9	17	18	5	4	4	4	11	15	7	102
Thika hort. research station.	55.0	47.0	119.0	93.0	207.0	168.0	35.0	27.0	14.0	75.0	164.0	66.0	1004.0
	4	4	9	14	16	11	4	4	2	5	15	7	86
Embu Met. Station	65.0	60.0	111.0	322.0	189.0	25.0	38.0	44.0	40.0	157.0	259.0	54.0	1364.0
	7	4	11	20	15	4	9	10	4	12	17	10	123
Kindaruma fisheries	49.0	37.0	49.0	152.0	58.0	12.0	4.0	4.0	21.0	21.0	201.0	78.0	686.0
	5	2	4	10	5	1	1	2	4	3	14	8	59
Meru met. Station	80.0	39.0	126.0	282.0	86.0	5.0	10.0	8.0	16.0	140.0	328.0	139.0	1259.0
	7	6	8	17	10	3	3	3	4	9	17	12	99
Marimanti Met. Station	50.0	21.0	68.0	272.0	112.0	7.0	4.0	4.0	11.0	70.0	223.0	5.0	847.0
	4	3	4	12	6	2	2	1	1	4	12	6	57
Garissa met. Station	13.0	7.0	38.0	68.0	20.0	8.0	3.0	8.0	7.0	24.0	79.0	77.0	352.0
	2	1	4	6	2	2	1	2	1	3	8	5	37
Kitui Dam W. D. D.	60.0	52.0	122.0	262.0	56.0	10.0	4.0	5.0	13.0	56.0	290.0	104.0	1034.0
	5	4	8	13	5	3	2	2	2	4	15	8	71
Hola - Tana irrigation scheme	27.0	17.0	37.0	70.0	47.0	37.0	18.0	18.0	29.0	30.0	86.0	55.0	471.0
	3	3	7	7	6	4	3	4	2	4	8	5	55
Lamu met. Station	6.0	4.0	25.0	130.0	329.0	164.0	75.0	40.0	39.0	40.0	39.0	28.0	919.0
	1	1	3	10	15	15	11	8	7	5	6	3	85

Source: National Water Master Plan

3.3.1.1 Temperatures

Temperatures within the Tana basin are related to altitude. The upper zone has temperatures ranging from an average of 26^0C to below 10^0C around the mountain. The middle and the lower zones have temperatures ranging from over 30^0C to above 10^0C with some extreme cases being over 35^0C. Temperature at the evaporating surface influences evaporation which is a major water loss. The amount of water vapour in the atmosphere is directly related to temperature. The distribution of water vapour varies with temperature, hence lowest in the highland and highest in the lowlands. The upper areas of Nyeri, Sagana, Thika, Embu and Meru have maximum temperature ranging from 23^0C to 26^0C while the minimum are between 12^0C and 15^0C. Lower areas around Marimanti, Kindaruma, Garissa and Hola have the maximum ranging from 34^0C to 32^0C while the minimum are between 17^0C and 23^0C. The coastal areas around Lamu have maximums of 30^0C and minimums of 24^0C. The temperatures are generally influenced by altitude and the coastal climatic conditions.

3.3.1.2 Relative Humidity

Relative humidity is the relative measure of amount of moisture in the air to the amount of moisture needed to saturate the air at the same temperature. The higher zones which have more rainfall have high relative humidity and less evaporation. The middle and the lower which have less rainfall have lower relative humidity and more evaporation. The relative humidity will influence evaporation and by extension the crop water requirement in cases of irrigation.

3.3.1.3 Sunshine Hours and Wind run

The main source of energy at the earth's surface is radiation energy from the sun. It is the solar radiation that fuels the engine driving the hydrological cycle. The total amount of radiation falling on any point of the earth's surface is governed by the length of the day. The sunshine hours will influence the temperature which will lead to influencing evaporation. The wind will assist in replacing the saturated air with drier air for more evaporation. Therefore the long sunshine hours will assist in growth of the crops leading to high productivity as long as water requirement is met effectively, though this may influence temperature and evaporation. The wind run therefore influences evaporation hence the higher the wind run, the higher the evaporation.

3.3.1.4 Evaporation

Evaporation is the primary process of water transfer in the hydrological cycle. From the surface of the earth, water is evaporated and transferred to the temporary storage in the atmosphere which is the first stage of the hydrological cycle. Evaporation is therefore the loss of water to the atmosphere after heating and converting to water vapor. Level of evaporation shows the rate at which the water will be lost when exposed even during irrigation. This will lead to high evapo-transpiration. With high evaporation and by extension high evapo-transpiration, there should be necessary efforts to avail adequate water and take this into account when deciding the method of irrigation to be used.

3.3.2 Climate within Athi Basin

Within Athi basin, there are climatic monitoring stations. For an overview of the climatic conditions in the basin, Muguga K.A.R.I, Nairobi J.K.I. Airport Met station and Ruiru Jacaranda Coffee Research in upper zone have been considered. In the middle zone, Katumani Agromet Station, Makindu Met. Station and Loitoktok Outward Mt. School have been considered, while the lower zone has been represented by Malindi Airport Met. Station, Voi Met. Station and Mombasa Moi Airport Met. Station.

Table 3. 3: The considered meteorological stations within the Athi basin

Met. Station	Station No.	Location.	Altitude(m)	Sub basin
Muguga K.A.R.I	9136121	E36^{0}38'00''S01^{0}13'00''	2096	3BA
Nairobi J.K.I.A Airport Met station	9136168	E36^{0}55'00" S01^{0}19'00"	1624	3BA
Ruiru Jacaranda Coffee R.	9136084	E36^{0}54'00" S01^{0}05'00"	1608	3BC
Katumani Agromet St.	9137089	E37^{0}14'00" S01^{0}35'00"	1601	3E
Makindu Met Station	9237000	E37^{0}50'00" S02^{0}17'00"	1000	3F
Loitoktok Outward Mt. School	9237022	E37^{0}30'00" S02^{0}56'00"	1845	3G
Malindi Airport Met. Station	9340009	E40^{0}06'00" S03^{0}14'00"	20	3H
Voi Met. Station	9338001	E38^{0}34'00" S03^{0}24'00"	560	3L
Mombasa Moi Airport Met. Station	9439021	E39^{0}37'00" S04^{0}02'00"	57	3M

3.3.2.1 Rainfall and Rain days

Rainfall within Athi River basin varies with altitude with higher areas having more rain than the lower areas. The upper zone which comprises the tower (Aberdares ranges) with an altitude of above 1500m has rainfall which is above 1000mm per year. The middle zone which covers the area between 500m to 1500m has rainfall within the range of 600mm to 1000mm per year while the lower zone of below 300m has rainfall which increases towards the ocean from 600mm to around 100mm per year. The flowing are the monthly mean rainfall and rain days as per the stations considered.

Table 3. 4: Monthly mean rainfall (mm) and rain days considered meteorological stations

Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yearly Total
Muguga K.A.R.I.	63	48	75	235	174	44	24	24	27	52	126	77	969
	6	5	9	16	15	6	4	5	4	6	14	7	97
Nairobi J.K.I.A Met. Station	49	52	72	144	127	25	12	15	20	38	134	74	762
	4	4	8	13	8	3	1	4	3	4	12	7	71
Ruiru Jacaranda Coffee R.	52	46	99	250	186	46	28	29	34	68	156	74	1068.
	5	5	10	17	14	5	6	5	4	7	15	8	101
Katumani Agromet St.	50	45	89	147	65	11	7	5	9	35	164	84	711
	4	4	7	12	7	2	1	2	1	3	14	8	65
Makindu Met	42	30	77	113	29	2	1	1	2	28	172	115	612

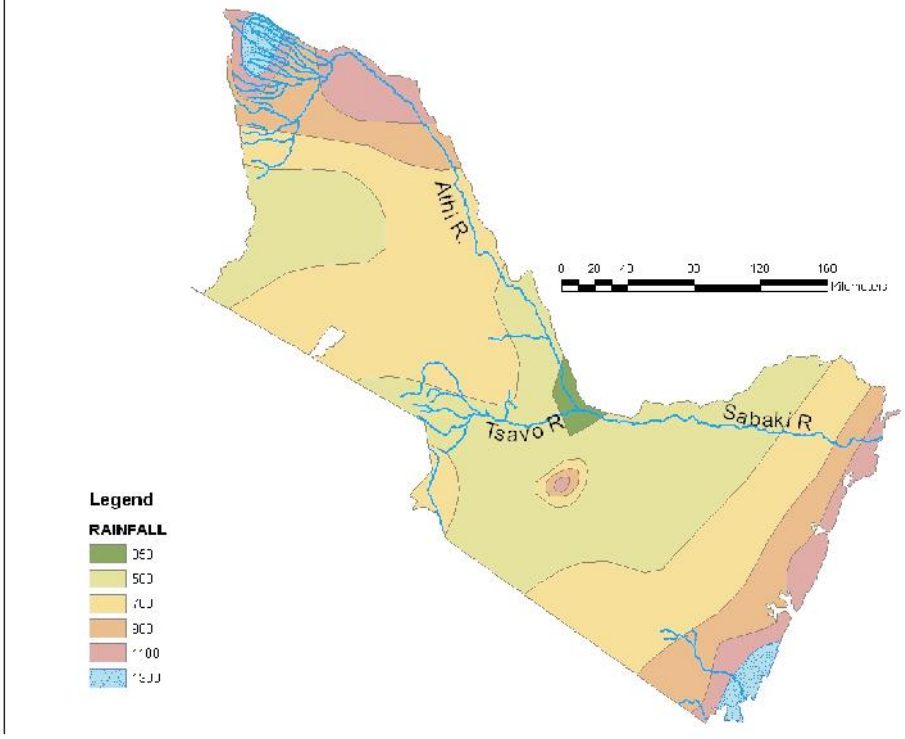
Station.	4	3	7	10	3	1	2	2	1	4	11	8	56
Loitoktok Outward Mt Sch.	94	92	107	153	24	5	6	5	8	26	228	145	893
	8	8	8	12	5	2	3	2	2	4	16	12	82
Malindi Airport Met. Station.	11	17	36	163	298	154	91	64	47	68	75	35	1059
	2	2	3	11	17	12	12	9	7	6	6	3	90
Voi Met. Station.	34	29	79	100	30	6	3	8	15	26	106	119	555
	4	6	7	13	8	3	2	3	2	3	10	7	68
Mombasa Moi Airport Met Station.	38	16	55	161	236	76	67	65	74	96	95	70	1049
	4	2	5	10	14	9	11	9	9	10	9	6	98

Source: National Water Master Plan.

It is clear that in most of the stations, there is a trend of generally dry periods during the months of June, July, August, September, January and February. The stations in upper zone registered high rainfall of over 900mm per year while the lower zone registered low rainfall of below 700mm per year except Malindi Airport and Mombasa Moi Airport meteorological station due to conditions which are influenced by the coastal climatic conditions. Muguga, Makindu, Nairobi JKIA and Ruiru have three months with over 100mm of rain while Loitoktok have four months of the same category. Katumani, Malindi and Mombasa Moi airport have only two months with over 100mm rainfall.

In upper zone and coastal zone, it shows that the rainfall amount per month is enough to sustain the crops in some wet months. The crops will require supplement irrigation during the dry periods. In the middle and some lower zones, most months do not have enough rainfall to sustain agriculture hence need to supplement crop water requirement during most of the months which are dry for even the rain days are very few. As per the records, the Malindi and Ruiru have four months with more than 10 rain days while Muguga, Loitoktok and Mombasa have three months with more than 10 rain days. Katumani, Makindu and Voi have two months with at least 10 rain days while Nairobi JKIA have one month with over 10 rain days. The rainfall distribution in the catchment is as shown on the map below.

Figure 3. 2: Rainfall distribution in Athi Catchment area



Source: Athi Catchment Management Strategy

It can therefore be concluded that areas of less rainfall have few rain days while those areas with high rainfall have more rain days generally.

3.3.2.2 Temperature

Temperatures within Athi River basin vary with altitude. The upper zone has temperatures ranging from an average of 26^{0}c to below 10^{0}c around the mountain. The middle and the lower zones have temperatures ranging from over 20^{0}c to above 30^{0}c with some extreme cases being over 35^{0}c. Temperature at the evaporating surface influences evaporation which is a major water loss. The flowing are the monthly mean daily temperature as per the stations considered

Table 3.5: Monthly mean daily maximum and minimum temperatures (^{0}C) of the considered meteorological stations

Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yearly Mean
Mugaga K A.R.I	22.4	23.2	23.2	21.6	19.9	18.9	18.2	18.8	21.0	22.1	20.7	21.3	20.9
	11.1	11.5	12.2	12.5	11.6	9.8	8.9	9.0	9.4	11.0	11.7	11.3	10.8
J.K.I.A	26.6	27.7	27.6	26.0	24.6	23.6	22.5	23.1	25.6	26.7	25.2	25.5	25.4

Airport	11.9	12.4	13.2	14.5	13.5	11.5	10.7	10.8	11.0	12.6	13.3	29.6	12.3
Ruiru Jacaranda Coffee R.	26.3	27.7	27.4	25.7	24.5	23.3	22.4	22.7	25.2	26.3	24.5	24.8	25.1
	12.3	12.6	13.6	14.9	14.2	12.3	11.4	11.7	11.9	13.4	14.0	13.1	13.0
Katumani Agromet. St.	25.8	27.1	26.4	25.1	24.2	23.0	22.1	22.6	25.1	26.3	24.1	24.2	24.7
	13.8	14.3	15.3	15.7	14.3	12.0	11.6	11.6	12.2	13.8	15.1	14.3	13.7
Makindu Met. Station.	29.0	30.7	30.8	29.5	28.3	27.4	26.4	26.8	28.6	29.8	28.5	27.6	28.6
	17.3	17.8	18.4	18.5	16.9	14.7	13.8	14.2	15.1	16.9	18.0	17.8	16.6
Loitoktok Outward Mt School	24.0	24.8	24.6	22.5	21.8	20.7	20.2	20.6	22.0	23.3	23.1	22.8	22.5
	11.6	11.7	11.5	11.6	10.6	9.0	8.7	8.6	8.7	9.9	11.6	12.0	10.5
Malindi Airport Met. Station	30.8	30.9	31.8	31.1	28.8	27.9	27.3	27.4	28.3	29.6	30.5	30.8	29.6
	23.3	23.5	23.9	24.2	23.4	22.6	22.0	21.6	21.7	22.2	22.8	23.4	22.9
Voi Met. Station	31.6	32.9	33.3	31.8	29.9	29.0	28.1	28.0	29.2	31.1	31.4	30.6	30.6
	20.1	20.2	20.8	20.4	20.0	18.3	17.5	17.2	17.6	18.9	20.1	20.4	19.3
Mombasa Moi Airport Met Station	32.0	32.3	32.6	31.3	29.3	28.4	27.7	28.0	28.9	29.7	30.6	31.6	30.2
	23.2	23.6	24.2	23.9	22.7	21.3	20.4	20.3	20.8	22.0	23.1	23.3	22.4

Source: National Water Master Plan.

The amount of water vapor in the atmosphere is directly related to temperature. The distribution of water vapor varies with temperature, hence lowest in the highland and highest in the lowlands. Upper areas of Muguga, Ruiru and Nairobi JKIA have maximum temperature ranging from 21^0 c to 25^0 c while the minimums are between 10^0c and 13^0c. Lower areas around Katumani and Makindu have the maximums ranging from 25^0 c to 28^0 c while the minimums are between 13^0 c and 16^0 c. The coastal areas around Malindi and Mombasa have maximums of 30^0 c and minimums of 22^0 c. Therefore, temperatures are generally influenced by altitude and the coastal climatic conditions.

3.3.2.3 Relative Humidity

The relative humidity is the relative measure of amount of moisture in the air to the amount of moisture needed to saturate the air at the same temperature. The higher zones which have more rainfall have high relative humidity and less evaporation. The middle and the lower which have less rainfall have lower relative humidity and more evaporation. The flowing is the monthly relative humidity as per the stations considered.

Table 3. 6: Monthly mean daily maximum and minimum Relative Humidity (%) of considered meteorological stations

Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yearly Mean
Muguga K.A.R.I	75	74	80	84	85	88	92	90	83	82	87	79	83
	49	46	48	60	69	65	65	63	52	49	60	58	57
Nairobi J.K.I.A Met. St.	94	91	94	97	97	95	94	93	94	95	97	97	94
	76	77	81	86	84	84	85	83	79	77	84	80	81
Ruiru Jacaranda Coffee R	73	70	78	84	84	82	83	82	79	78	83	79	79
	51	46	46	58	61	58	60	59	50	48	58	58	54
Katumani Agromet St.	77	78	80	85	82	78	80	79	75	71	83	81	79
	51	49	52	65	63	56	57	57	47	43	59	58	54
Makindu Met Station	82	78	78	80	78	76	76	75	72	72	81	82	77
	48	42	43	51	51	46	45	43	40	39	51	56	46
Loitoktok OutwarMt. School.	77	75	73	82	82	83	81	79	77	75	78	81	78
	69	67	68	77	72	73	71	72	66	68	72	77	71
Malindi Airport Met. Station	78	77	75	80	83	80	81	79	76	75	77	78	78
	67	65	66	69	75	72	73	72	69	68	70	68	69
Voi Met Station	71	71	73	79	77	72	73	74	72	66	71	85	72
	44	42	46	57	58	53	49	49	44	38	49	55	45
Mombasa Moi Airport Met. Station.	77	76	79	84	86	85	86	86	82	81	80	79	81
	62	60	62	67	71	67	68	66	64	65	68	66	65

Source: National Water Master Plan.

The relative humidity will influence evaporation and by extension the crop water requirement in case of irrigation.

3.3.2.4 Sunshine Hours and Wind run

The main source of energy at the earth's surface is radiation energy from the sun. It is the solar radiation that fuels the engine driving the hydrological cycle. The total amount of radiation falling on any point of the earth's surface is governed by the length of the day. The sunshine hours will influence the temperature which will lead to influencing evaporation. The wind will assist in replacing the saturated air with drier air for more evaporation. The flowing is the monthly daily hours and wind run as per the stations considered

Table 3. 7: Monthly mean daily sunshine hours and wind run (km) of considered meteorological stations

Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yearly Mean
Muguga K.A.R.I	9.3	9.4	8.9	7.3	6.3	5.8	4.9	5.2	7.1	8.1	7.4	8.7	7.4
	199.6	195.7	207.5	176.3	136.0	150.5	112.7	126.9	152.3	191.6	203.2	200.1	171.0
Nairobi J.K.I.A	9.4	9.5	8.5	7.2	6.1	5.3	4.1	4.1	5.9	7.3	7.1	8.7	6.9
	174.9	175.9	183.1	139.8	116.5	101.2	105.2	117.0	133.7	164.5	179.3	179.8	147.6
Ruiru	8.8	9.3	8.3	6.6	6.0	3.9	3.4	4.0	6.0	7.3	6.5	7.9	6.5

Jacaranda Coffee R.	69.9	73.2	71.2	59.0	47.7	41.4	39.8	45.1	57.0	61.1	60.6	65.0	57.6
Katumani Agromet. St.	9.2	9.6	8.9	7.5	7.0	5.0	4.1	4.3	6.5	8.6	7.5	8.4	7.2
	118.6	118.0	115.4	89.6	72.5	70.0	72.2	83.4	103.5	123.3	113.4	106.3	98.9
Makindu Met. Station	8.7	8.8	8.7	8.0	7.5	6.1	5.4	5.5	7.6	8.8	7.9	8.3	7.6
	98.0	108.6	113.4	97.3	89.9	89.6	110.1	114.2	139.4	149.2	118.4	93.8	110.2
Loitoktok Outward Mt. School.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
	41.7	38.0	37.2	39.5	39.6	27.8	34.1	40.6	59.4	67.2	40.2	34.6	41.7
Malindi Airport Met. Station	9.4	9.2	9.2	7.2	7.1	7.6	7.7	8.4	9.1	9.3	9.4	9.6	8.6
	265.9	257.9	232.6	200.6	235.9	270.2	275.6	270.7	210.8	225.0	187.7	216.7	237.5
VOi Met Station	8.1	7.4	7.7	7.0	7.0	6.9	6.1	5.7	6.7	8.4	7.7	7.8	7.2
	92.5	95.1	100.0	116.9	149.6	161.4	168.3	179.3	156.8	137.5	103.2	87.0	129.0
Mombasa Town Met. Station.	8.3	8.9	8.9	7.6	6.5	7.3	7.0	8.0	8.4	8.9	8.9	8.7	8.1
	141.3	143.2	138.0	158.5	162.3	168.6	162.2	158.1	153.8	148.2	123.0	128.5	148.8

Source: National Water Master Plan.

The long sunshine hours will assist in growth of the crops leading to high productivity as long as water requirement is met effectively, though this may influence temperature and evaporation. The wind run therefore influences evaporation hence the higher the wind run, the higher the evaporation.

3.3.2.5 Evaporation

Evaporation is the primary process of water transfer in the hydrological cycle. From the surface of the earth, water is evaporated and transferred to the temporary storage in the atmosphere which is the first stage of the hydrological cycle. The flowing is the daily evaporation as per the stations considered

Table 3. 8: Monthly mean daily evaporation (mm) of the considered meteorological stations

Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
Muguga K.A.R.I	191	189	202	141	105	89	83	96	139	177	142	167	143
Nairobi J.K.I.Airport Met. Station	221	218	233	172	134	114	113	123	165	216	172	192	172
Ruiru Jacaranda Coffee R.	169	170	172	125	108	94	84	96	140	159	116	143	131
Katumani Agromet Station	170	183	200	162	121	102	99	115	160	199	149	147	150
Makindu Met Station.	177	187	211	174	159	151	147	162	196	220	174	154	176
Loitoktok Outward Mt. School.	135	126	142	119	110	87	83	126	133	162	124	115	121

Malindi Airport Met. Station	172	179	193	178	145	149	128	144	154	160	162	140	158
Voi Met Station	191	195	211	174	169	173	174	167	178	206	181	170	182
Mombasa Moi Airport Met. Station	210	203	221	184	155	144	138	158	178	197	188	191	180

Source: National Water Master Plan.

Evaporation is therefore the loss of water to the atmosphere after heating and converting to water vapor. Level of evaporation shows the rate at which the water will be lost when exposed even during irrigation. This will lead to high evapo-transpiration. With high evaporation and by extension high evapo- transpiration, there should be efforts to avail adequate water and take this into account when deciding the method of irrigation.

3.4 Water Resources analysis/ hydrology

3.4.1 Water Resources in Tana Basin

Water resources available in Tana River basin consist of surface water runoff and sustainable yield of ground water. In the Tana basin, the surface water is more in the perennial rivers which include the Sagana river system, Thika river system, Thiba river system, Mutonga river system, Kathita river system, Rujiweru river system and the main Tana River. These rivers flow throughout the year. There are seasonal rivers like Tyaa and Tiva which flow seasonally and dry up during sunny periods. The flow regimes in rivers are controlled by the seasons of rains with the long rains in March to May and the short rains from October to December. Tana River is perennial with its flow moderated by the development of the five dams (Kiambere, Kindaruma, Gitaru, Kamburu and Masinga) which are majorly for hydropower production. Tana basin produces 70% of the national hydropower which is 40% of the national power generation plus 80% of water supplied to Nairobi city.

The water resources available are monitored through a network of monitoring stations for rainfall, river flow, ground water levels and water quality of both ground water and surface water. The available water resource consists of the surface water runoff and sustainable yield of ground water. The sustainable yield of groundwater has been derived as 10% of the groundwater recharge in the catchment area. Table 3.9 below shows the estimated annual available water resources in Tana catchment area

Table 3. 9: Annual available water resources in the Tana Catchment area (mcm/yr)

Year	Surface Water	Ground Water	Total
2010	5,858	675	6,533
2030	7,621	567	7,828
Variation	24%	-16%	20%

Source: National water master plan.

The forecast shows an increase in surface water and a decrease in ground water. This is attributed to the possible impacts of climate change phenomenon. The available water resources are for nature and man in

his needs. The available water against the population gives the water available per capita per year (per person per year). Table 3.10 shows the projected per capita of the water available.

Table 3. 10: Per capita water of available water resources

	2010		2030		2050	
Catchment	population	Per capita	population	Per capita	population	Per capita
Tana	5.73m	1,142m^3/p/yr	10.37m	758 m^3/p/yr	14.81m	534 m^3/p/yr
Kenya	38.53m	586 m^3/p/yr	67.84m	393 m^3/p/yr	96.89m	294 m^3/p/yr

Source: National water master plan.

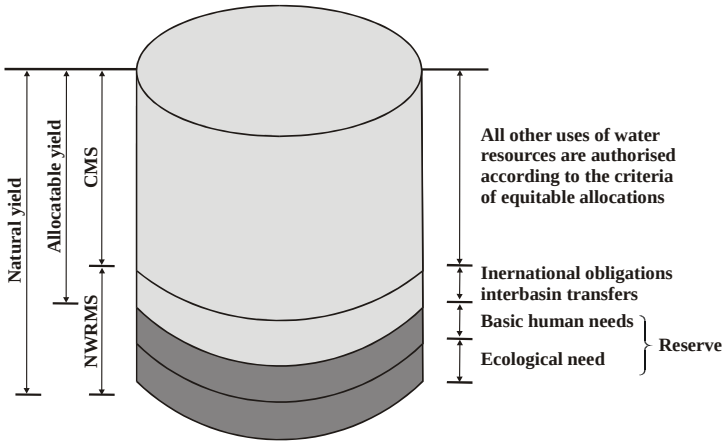
Therefore, the per capita for Tana catchment and even the country is currently below the World Health Organisation (WHO) recommended value of over 1000m^3 per capita per annum for any country to be comfortable with its available water resources. Therefore Kenya is a water scarce country according to WHO. Rainfall is the source of both surface water and groundwater resources. The hydrological analysis in the national water master plan study found out that in the future, rainfall may increase due to climate change in the western highland areas and may be unchanged or decrease in the Coastal areas in the long rain season, but the rainfall may almost be unchanged throughout the county and slightly decrease in the coastal areas during the dry season. Therefore the availability of water resources is expected to be more unevenly distributed spatially in future. Due to climate change, the current temperatures are expected to increase by 1 degree Celsius by 2030 and by about 2 degrees Celsius by 2050 as per National Water Master Plan (NWMP) estimates.

The surface water study in the NWMP showed that all sub basins in Tana catchment area will have severe water deficit due to increase in water demand by 2030. Although in 2010, the water demand was estimated to be 14% of the available water resources, the water demands for 2030 are expected to be 105% of the available water resources. The ratio of 105% of water demand to water resources, which is called the water stress ratio, indicates very severe situation in the water balance especially when compared with the ratio of 40% regarded to indicate severe water stress. The available water resources are all surface water runoff and 10% of rechargeable ground water which is sustainable. This gives the water resources for use in normal flow and storage of the flood flows. However, the proposed water allocation plan for 2030 gives water stress ratio of 41% for surface water and 37% for ground water. It is projected that surface water will take care of 93% of the water demands while ground water will take care of 7% of the water demands. This should be the guide for water allocation in Tana catchment according to NWMP. From the analysis on water balance, it is clear that the Tana Basin has been experiencing a negative water balance. During the rainy season, the Tana Basin discharges a large volume of flood flow to the Indian Ocean.

For irrigation water abstraction, the Water Act 2002 requires that the applicant develops adequate storage facilities, such that abstraction is not undertaken from normal flow. It is proposed that any future irrigation development should be accompanied by the development of water storage facilities to provide the required irrigation water. It has been calculated that storage of 150,000m^3 will allow one-season irrigation for an area of 10 hectares, given 1 litre per second per hectare of irrigation water application. This means that for

the identified projects with a minimum of 40 hectares, the minimum storage facilities of 600,000 m^3 will be required. The water available is allocated as per allocation plan which includes the ecological and basic human needs, reserves; inter basin transfer and international obligation then the allocation to other uses as per demand and priority while guided by the principals of equity (equitable allocation).

Figure 3. 3: Determination of allocation of yield- Tana basin



Source: Tana Catchment Management Strategy

The water available minus the reserve and the water allocated to inter basin transfer, international obligation and the water users give the balance which can be positive or negative.

Table 3. 11: Water balance for the Tana Catchment (mcm/yr)

2010			2030		
Water resources	Water demands	Demand percentage	Water resources	Water demands	Demand percentage
6,533	891	14%	7,828	8,241	105%

The water demand will increase drastically due to increase in population from 5.73 million to 10.37 million and irrigation from 64,425ha to 546,875ha though bigger areas are available.

3.4.2 Water resources in Athi basin

Water resources available in Athi basin consist of surface water runoff and sustainable yield of ground water. The surface water is more in the perennial rivers which include Ruiru, Nairobi, Thiririka, Ndarugu, Tsavo, Kibwezi, Lumi and the coastal rivers. All these perennial rivers are small with relatively little water in their systems. These rivers flow throughout the year. There are seasonal rivers like Thwake, Kaiti and Mbagathi which flow seasonally thus dry up during dry periods and flow during the rainy periods. The flow

regimes in rivers are controlled by the seasons of rains with the long rains in March to May and the short rains from October to December. Athi River is relatively perennial with its flow being very low during dry periods and even some sections of the river almost drying during those periods.

The water resources available are monitored through a network of monitoring stations for rainfall, river flow, ground water levels and water quality of both ground water and surface water. According to the Athi Catchment Management Strategy, the rainfall is monitored through 33 stations currently though the targeted number is 50 stations while surface water (river flow) is monitored through 18 monitoring stations though the target is 31 stations. The ground water is monitored through 25 stations though the target stations are 71 while monitoring of water quality for surface water and ground water is through 26 and 18 stations respectively. However, for water quality monitoring of surface and ground water, the target is 31 and 18 respectively.

The available water resource consists of the surface water runoff and sustainable yield of ground water. The sustainable yield of groundwater was derived as 10% of the groundwater recharge in the catchment area. The annual available water resources in Athi catchment area has been estimated as in the table below.

Table 3. 12: Annual available water resources in the Athi catchment area (mcm/yr)

Year	Surface Water	Ground Water	Total
2010	1,198	305	1,503
2030	1,334	300	1,634

Source: National Water Master Plan.

There is future increase in surface water and a decrease in ground water due to the impacts of climate change. The available water resources are for nature and man in his needs. The available water against the population gives the water available per capita per year (per person per year). Below is the tabulated per capita of the water available.

Table 3. 13: Per capita water of available water resources

	2010		2030		2050	
Catchment	population	Per capita	population	Per capita	population	Per capita
Athi	9.79m	464m^3/p/yr	20.54m	226 m^3/p/yr	29.33m	183 m^3/p/yr
Kenya	38.53m	586 m^3/p/yr	67.84m	393 m^3/p/yr	96.89m	294 m^3/p/yr

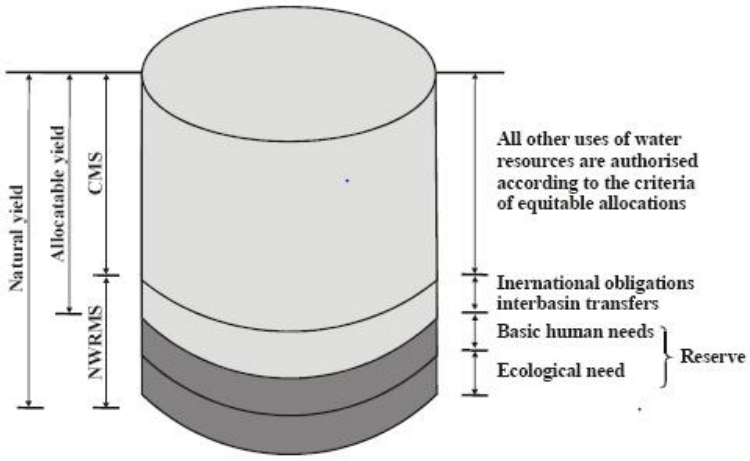
Source: National Water Master Plan.

The per capita for Athi and even the country is currently below the WHO recommended value of over 1000m^3 per capita per annum for any country to be comfortable with its available water resources. Kenya is therefore a water scarce country according to WHO sustainable levels. Rainfall is the source of surface water and groundwater.

The surface water study in the NWMP showed that all sub basins in Athi catchment area had severe water deficit due increase in water demand by 2030. Although in 2010, the water demand was estimated to be 76% of the available water resources, the water demands for 2030 are expected to be 281% of the available water resources. The ratio of 76% and 281% of water demand to water resources, which is called the water stress ratio, indicates a very tight situation in the water balance in 2010 and extremely very severe situation in 2030 especially when compared with the ratio of 40% regarded to indicate severe water stress. This gives the reason why Tana catchment (through Sasumua dam and Ndakaini Dam) has to provide for the deficit of water demand based on the available water resources in Athi catchment. This implies that the available water resources and demands should maintain a balance by maximum utilization of water resources. The available water resources are all surface water runoff and 10% of rechargeable ground water which is sustainable. This gives the water resources for use in normal flow and storage of the flood flows.

From the analysis on water balance, it is clear that the Athi Basin has been experiencing a negative water balance. During the rainy season, the Athi Basin discharges a large volume of flood flow (especially the seasonal rivers of Thwake, Kaiti and Mbagathi) to the Indian Ocean. For irrigation water abstraction, the Water Act 2002 requires that the applicant develops adequate storage facilities, such that irrigation abstraction is not undertaken from normal flow. It is proposed that any future irrigation development should be accompanied by the development of water storage facilities to provide the required irrigation water. The water available is allocated as per allocation plan which includes the ecological and basic human needs, reserves; inter basin transfer and international obligation then the allocation to other uses as per demand and priority while guided by the principals of equity (equitable allocation).

Figure 3. 4: Determination of allocation of yield- Athi basin



Source: Athi catchment Management strategy

The water available minus the reserve and the water allocated to inter basin transfer, international obligation and the water users give the balance which can be positive or negative.

Table 3. 14: Water balance for Athi catchment (mcm/yr)

2010			2030		
Water resources	Water demands	Demand percentage	Water resources	Water demands	Demand percentage
1,503	1,145	76%	1,634	4,585	281%

The water demand will increase drastically due to increase in population from 9.79 million to 20.54 million and irrigation from 44,898ha to 91,006ha though bigger areas are available.

3.4.3 Water Use

3.4.3.1 Water use in Tana Catchment

There are different water uses within any catchment. There are the basic uses, the major uses and other uses. The basic uses include the reserve (ecological needs and basic human needs), international obligations and water basin transfer. The major uses include domestic, livestock, industrial, energy and irrigation. Other uses may include recreation, tourism and scenic attraction etc. Domestic water uses include the use in urban and rural areas by the population in their homes, work places and operational areas. The industrial water use is mainly for industrial activities in industries. The irrigation water use is for food production through irrigated agriculture. This can be through flood, basin, furrow, sprinkler and drip irrigation methods which have varying efficiency ranging from 50% (basin/flood method) to 90% (drip method). Aquaculture water uses include fisheries where the water is retained and later returned to the water body system. Energy water use is through hydropower production and is 100% returnable to the water system immediately after use. Livestock use is by cows, goats, sheep, camels, donkeys etc. as per their need wherever they are (could be zero grazing, open grazing and nomadic grazing).

The first priority on water resource use is the domestic purposes as per water Act 2002, section 32 (2). In Tana Catchment, the uses compete for the available water resources. The use of water will depend on the population and how the ratio is of the urban and rural plus the amount of land under irrigation and the method of irrigation while the level of other activities will influence the amount of water demand. In Tana catchment, the possible irrigation area by 2030 will be 226,224ha while by 2010 it was 38, 402ha by private, 14,823 ha by small scale and 11,200ha by large scale (total 64,425 ha).

Table 3. 15: Population in the Tana Catchment

	2010			2030		
	Rural	Urban	Total	Rural	Urban	Total
Population (million)	4.69	1.04	5.73	4.03	6.34	10.37

According to NWMP, by 2010, 66.1% of population was in the rural while 33.9% were in urban. However, it is projected that by 2030 67.8% will be in the urban areas while 32.2% will be in the rural due to rural urban migration which is taking place at a very high rate. In urban areas water consumption is higher than in the rural area with the consumption rate being within 250L/P/D (litres per person per day) and 75 L/P/D, while in the rural areas, it is within 60L/P/D and 40 L/P/D as per the standard design criteria. As there will be more in the urban than in the rural areas, irrigation will be the alternative to rain fed agriculture to ensure adequate food for the Kenyan population. The water demands will be based on the available land and the available water possibly through storage.

In Tana catchment, by 2010, the irrigation land was 64,425ha with a demand of 696mcm/year while by 2030 the possible irrigated area will be 226,224ha with a water demand of 2,697mcm/year. Therefore the biggest water users are irrigation, domestic, livestock, industrial, inland fisheries and wildlife in that order. Water use for hydropower generation is 100% returnable to the water way.

3.4.3.2 Water use in Athi Catchment

There are different water uses within any catchment. There are the basic uses, the major uses and other uses. The basic uses include the reserve (ecological needs and basic human needs), international obligations and inter basin transfer. The major uses include domestic, livestock, industrial, energy and irrigation. Other uses may include recreation, tourism and scenic attraction etc. In Athi Catchment, the uses compete for the available water resources. The use of water will depend on the population and how the ratio is of the urban and rural plus the amount of land under irrigation and the method of irrigation while the level of other activities will influence the amount of water demand.

Table 3. 16: Population in the Athi Catchment

	2010			2030		
	Rural	Urban	Total	Rural	Urban	Total
Population (million)	3.28	6.51	9.79	2.81	17.73	20.54

In Athi catchment, the possible irrigation area by 2030 will be 91,006ha while by 2010 the existing area under irrigation was 44,898ha. According to NWMP, by 2010, 66.1% of population was in the rural in Kenya while 33.9% were in urban. However by 2030 it is projected that 67.8% will be in the urban areas while 32.2% will be in the rural due to rural urban migration which is taking place at a very high rate. As there will be more people in the urban areas than in the rural areas by 2030, irrigation will be the alternative to rain fed agriculture to ensure adequate food for the Kenyan population. The water demands will be based on the available land and the available water possibly through storage. In Athi catchment, by 2010, the irrigation land was 44,898ha with a demand of 498mcm/year while by 2030 the possible irrigated area will be 91,006ha with a water demand of 917mcm/year.

3.4.4 Sources of domestic water

The domestic water could be from piped water supply system with individual connections or communal water point or water kiosks. They are common in urban centers and within the rural areas covered by water supply. These areas are provided with water by the water service providers. There are other people who get water from springs, wells and boreholes. The individuals fetch water from these sources for the family depending on the water demand and their ability. There are other people getting water from water vendors. There is another set of people who get water from streams, rivers, lakes, ponds etc. These people target the nearest water body and get the amount of water they need. Water from rivers is usually targeted for domestic use especially where the gravity systems are possible because pumping is expensive. Ground water through boreholes or wells is targeted where there is no surface water or the water quality of the surface water becomes a challenge.

3.4.5 Ground water situation

3.4.5.1 Ground water situation in Tana basin

The occurrence of ground water depends on the geology of the area. The subsurface geology in Tana catchment generally is composed of the Archaean age Mozambique belt basement system of rocks which are mostly metamorphic rocks, the Miocene and Pleistocene volcanic rocks, the tertiary and the quaternary sediments followed by the recent alluvium deposits along river flood plains, all in that order of stratigraphic succession. In terms of ground water, the Tana catchment can be addressed in zones which include upper, middle and lower zones. The upper zone of Tana Catchment comprises of volcanic formation in the slopes of Mt Kenya, the Aberdares and Nyambene hills within an altitude above 1300m above mean sea level. Different recharge transits and discharge zones characterize these aquifer systems in this upper zone. The good inter - granular and fracture flow aquifers in this zone offer relatively good quality water with yields that vary from $5m^3/hr$ to over $30m^3/hr$.

The middle zone of the catchment is generally semi-arid to arid and is within the areas below the altitude of 1,300m above mean sea level and above the altitude 500m above mean sea level. The aquifers are localized and typically poor. The area extends over Tharaka, Kitui, Mwingi and parts of Machakos. The lower zone of the Catchment lies below 500m above mean sea level. The zone comprises of tertiary sediments and quaternary Alluvium deposits. The aquifer are localized and semi regional. This area extends to Tana River, lower parts of Kitui, Garissa and Lamu which include the coastal zone. The ground water is poorly exploited in the Tana Catchment.

3.4.5.2 Ground water situation in Athi basin

The occurrence of ground water depends on the geology of the area. The Athi catchment generally is characterized by varying geological conditions which lead to different aquifers. The catchment can be addressed in terms of upper zone (around Nairobi, Chulu and Kilimanjaro), middle zone (the plains and the plateau) and lower zone (coastal area). The hydrogeology determines the aquifer characteristics of the Athi Catchment area which is usually localized aquifer system. These comprises of a complex of local and semi - regional aquifers. The Athi catchment region is characterized by varying hydrogeological conditions which

leads to different aquifers. The upper zone, which is predominately volcanic, has relatively good aquifers (over 10 m^3/hour of borehole tested yields), of considerable value for domestic, community and commercial water supply. The middle zone has localized aquifers in the fractured and weathered zones of the Basement system, with alluvial aquifers being locally important; the Chyulu Hills host the source aquifer that supplies the Mzima Springs, as well as the spring units that flow from the eastern side of the range (from Kiboko in the north to Umani further south). Volcanic aquifers on the northern flank of Kilimanjaro host a number of springs that are good for water supply like Nolturesh or Mzima springs and for irrigation like Kimana or Njoro Kubwa springs. The coastal zone is threatened by seawater intrusion, worsening with proximity to the oceanic front. Where abstraction is limited, the coastal coral limestone and sand aquifer is of considerable commercial importance, and the Tiwi and Baricho Aquifers are key water supply. The coastal hinterland aquifers are typically poor and often brackish.

3.4.6 Water quality and quantity

3.4.6.1 Water quality and quantity in Tana basin

Water quality on the surface and ground water in Tana basin varies within the upper, middle and lower zones. The quantity of surface water and ground water also varies within the three zones. Water quantity and quality are some of the challenges experienced in Tana basin with the quantity ranging from scarcity to flooding. In the upper zone it is high potential zone though characterized by catchment destruction leading to high and faster runoff flows. Due to high population densities, the upper zones have over abstraction cases. This is the zone with agro-based factories like coffee and tea factories. The urbanization, the factories and industries contribute to substantial pollution of water resources.

Some towns have no sewerage system while those who have sewerage systems have poor coverage of the town while some of the towns have treatment systems which cannot manage effectively the generated waste water (effluent) from the towns leading to release of effluent not fully treated. Due to population pressure, encroachment of wetlands, water catchment area and the mushrooming of informal settlements, water quality has been compromised. In the middle zone, agriculture potential is low though currently there is an aggressive agricultural practice leading to overstocking and catchment degradation which leads to high erosion rates. The ground water is one of the water sources but affected by random quarrying and sand harvesting.

The water quality is also adversely affected by effluent discharged from settlement as there is no conventional waste water treatment plants as well as chemicals runoff from the farms. There are pockets where groundwater has excessive fluoride, iron or manganese etc. Also in the zone liquid effluent from big towns, factories, car washing and factories affect the water quality of both groundwater and surface water. The lower zone is characterized by water scarcity in time and space coupled by high evaporation hence high reliance on groundwater. The groundwater has high occurrence of salinity (fluoride and iron) due to the existing rock formation. Along the coast line there, is a challenge of sea water intrusion. Pollution in this zone is common from poor liquid effluent management of the towns and settlement, car washing and runoff from solid wastes damp sites.

3.4.6.2 Water quality and quantity in Athi basin

Water quality on the surface and ground water in Athi basin varies within the upper, middle and lower zones. The quantity of surface water and ground water also varies within the three zones. Water quantity and quality are some of the challenges experienced in Athi basin with the quantity ranging from scarcity to flooding. The upper zone is a high potential zone though characterized by catchment destruction leading to high and faster runoff flows. Due to high population densities and relatively small rivers, the upper zones have over abstraction cases. This is the zone with agro-based factories like coffee and tea factories. Urbanization, the factories and industries contribute to substantial pollution of water resources. Some towns have no sewerage system while those which have sewerage systems have poor coverage of the towns. Some of the towns have treatment systems which cannot manage effectively the generated waste water (effluent) from the towns leading to release of effluent not fully treated into local water bodies. Due population pressure, encroachment of wetlands and water catchment area by urban slum dwellers, water quality within the region has been compromised.

In the middle zone, agriculture potential is low though there is currently aggressive agricultural practice leading to overstocking and catchment degradation. This has led to high erosion rates. Ground water is one of the water sources within this area but it is inadequate due to poor yields. The water quality is affected by effluent from settlement (have no conventional sewerage systems) and chemicals applied in farms. There are pockets where groundwater has excessive fluoride, iron or manganese. Also in the zone, effluent from big towns, factories, car washing and dumping sites affect the quality of both groundwater and surface water. The lower zone is characterized by water scarcity in time and space coupled by high evaporation rate hence high reliance on groundwater. The groundwater has high occurrence of salinity due to the existing rock formation. Along the coast is a challenge of sea water intrusion. Pollution in this zone is common from poor effluent management within the towns and settlements, car washing and solid waste dump sites.

3.5 Wetlands within the programme area

3.5.1 General

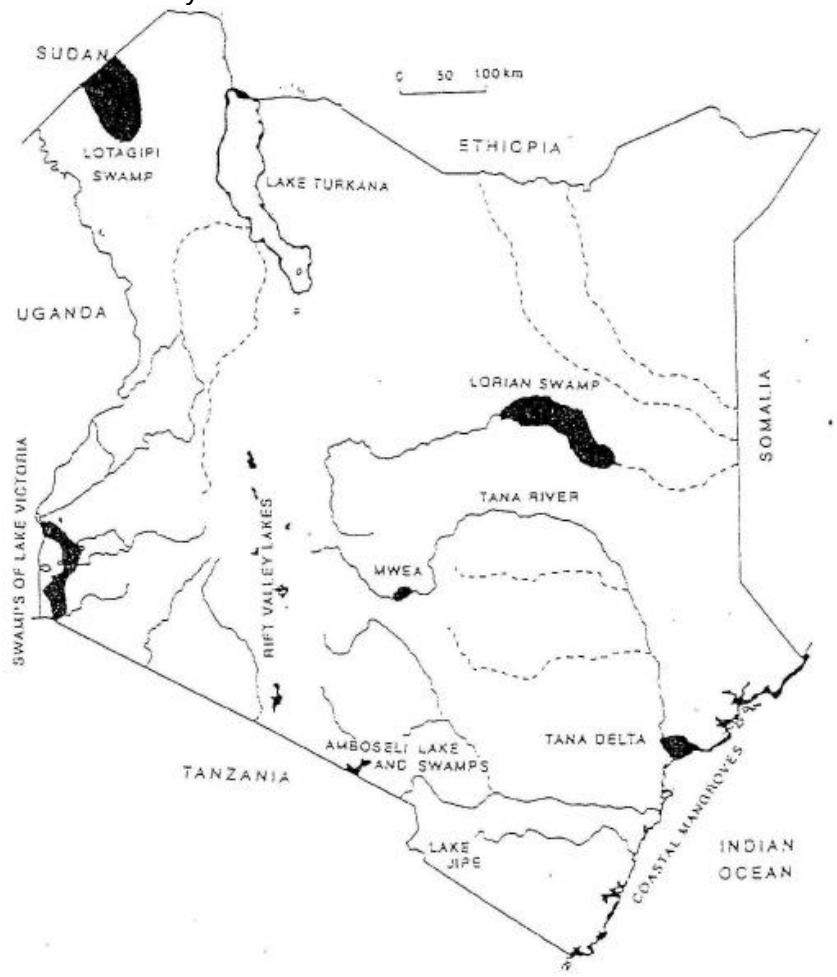
Wetlands are among the most productive ecosystems on earth. They allow interaction between water, soil, vegetation and light all year round or during a greater part of the year. The depth of the water is such that it allows photosynthesis to occur, making wetlands productive life-supporting ecosystems. It is this association of water, light, soil and plants that typifies various wetlands of Kenya which are famous for their spectacular avifauna and fisheries resources. Wetlands were the first ecosystem to receive international attention through the "Convention on Wetlands of International Importance especially as Habitats for Waterfowls", opened for signature at Ramsar, Iran, in February 1971. Kenya ratified this convention in 1990.

According to the Kenya National Environment Action Plan (NEAP) prepared in 1994, a substantial proportion of Kenya's water resources are found in wetlands, which cover 2 to 3% of the country's surface

area. These wetlands are diverse in type and distribution. Some of the larger wetlands of Kenya include the shallow lakes Nakuru, Naivasha, Magadi, Kanyaboli, Jipe, Chala, Elmentaita, Baringo, Ol'Bolossat, Amboseli and Kamnarok; the edges of Lake Victoria and Lorian, Saiwa, Yala, Shompole swamps; Lotikipi (Lotagipi) and Kano plains; Kisii valley bottoms and Tana Delta; and coastal wetlands including the mangroves swamps, sandy beaches, sea grass beds and coral reefs.

The list also includes various seasonal and temporary wetlands that occur where internal drainage allows water to collect in some seasons or in some years. These are found all over the country, including rock pools and springs in the southern part of Nairobi, west of Ngong Hills, and at Limuru. Man-made wetlands include the dams, primarily meant for hydropower and water supply, and wetlands created for purposes of wastewater treatment and rice paddies. Wetlands within the programme area are located within Tana and Athi river basins

Figure 3. 5: Wetlands in Kenya



3.5.2 Wetlands within Tana River basin

Within the Tana River basin, wetlands include the following:

3.5.2.1 The Tana River

The Tana River is Kenya's longest watercourse while the Tana River basin is one of the country's largest and richest wetlands. The Tana River catchment stretches from Mount Kenya and the Aberdare Mountain Range to the Indian Ocean where it empties before the coral reef drop off. The Tana River also supplies water to the Seven Forks hydroelectric power plants where a large proportion of the country's hydropower is generated (UNEP 2009).

3.5.2.2 The Tana Delta

Near the end of its nearly 1 000 km trek from the foothills of Mount Kenya to the Indian Ocean, the Tana River passes through a large floodplain of wetlands, riverine forests, woodlands, bushlands, fresh and brackish lakes, estuaries, mangroves and grasslands. The entire floodplain is commonly called the Tana Delta. The Delta's biodiversity is known to include many endemic or range restricted plants, primates, amphibians and reptiles.

The downstream Tana River basin also provides a habitat for 320 plant taxa. Fifty-eight of these are tree species, two of which are critically endangered, while the conservation status of 21 per cent of the plants is of concern. The area hosts seven plants on the IUCN Red list. These are Cynometra lukei which is classified as endangered and Oxystigma msoo, Angylocalyx braunii, Dalbergia vaciniifolia, Chytranthus obliquinervis, Diospyros greenwayi and Pavetta linearifolia which are categorized as vulnerable (Luke and others 2005). Globally threatened birds recorded in the delta include: the Lappet-faced Vulture (Torgos tracheliotos), Southern Banded Snake Eagle (Circaetus fasciolatus), Malindi Pipit (Anthus melindae) and the Basra Reed Warbler (Acrocephalus griseldis). The estuaries, mangroves and shorelines provide a habitat for a wide range of fish species. Three shark species listed under the CITES Appendix 1 have been recorded in the Tana Delta area.

Figure 3. 6: Wetlands within Tana River basin

3.5.2.3 Characteristics of the Tana River basin

The table below gives a summary of characteristics of Tana River basin

Table 3. 17: Characteristics of the Tana Basin

Basin and Basin area (sq. km.)	Major wetlands	Major land /wetlands uses	Pressures	Impacts
Tana 120 925 km^2	• Tana River • Tana River Delta • Seven Forks hydropower dams	• Large scale farming • Conservation • Irrigation • Pastoralism • Mining-sand • Fishing • Quarrying • Forestry • Hydropower	• Inappropriate land use • Overutilization of water • Conversion of land to agriculture • Overstocking of livestock • Conversion of	• Pollution • Soil erosion/ siltation • Overgrazing • Reduced water volume • Loss of critical habitats and species • Reduced

		generation • Recreation • Water supply	land to settlements • Loss of catchment forests • Increased demand for resources • Reduced water levels • Land subdivision and fragmentation	hydrological • capacity

3.5.3 Wetlands within Athi River basin

Apart from the Athi River itself, the wetlands in the Athi basin are also associated with the Nairobi River which originates from the Ondiri Swamp; the Mbagathi River which originates from the Ngong Hills; the Kiboko River whose main catchment is Endoinyo Narok and the Tsavo River, which drains the northern slopes of Mount Kilimanjaro. These rivers supply water to the Athi River which, like the Tana River, empties into the Indian Ocean. The Amboseli sub-basin (an internal drainage basin), situated north of Mount Kilimanjaro, is a significant component of this basin with Lake Amboseli being the main wetland in this sub basin. Although it is seasonal, it receives a regular water supply from Namanga River which comes from the Meto Hills. The basin also receives both surface runoff and underground water supply from Mount Kilimanjaro's melting snow. The seepage of underground water in the basin maintains a series of freshwater marshes, swamps and springs on the lake's eastern shores. In addition, there are seasonal wetlands, such as the Kimana pans, which fill with water during the long wet season.

3.5.3.1 Lake Amboseli

Amboseli National Park lies in the semi-arid bush and grassland savanna near the base of Mount Kilimanjaro. Its wetlands rely on hydro-geological connections with the mountain and receive much of their water through groundwater flows originating from the slopes of the Kilimanjaro. While Lake Amboseli and its associated Enkongo Narok and Loginye swamps are an important source of water to the park's biodiversity, the wetland system is nevertheless seasonal, filling only when there is adequate water during wet seasons.

Wetland and upland ecosystems in the Amboseli National Park have undergone considerable change in the past 50 years. The most notable change with regard to the vegetation is that the dense woodlands that covered roughly 30 per cent of the area in the 1950s had given way to scrub and grassland by 2000. During the same timeframe, average temperatures rose significantly and at a rate far greater than that of global warming.

3.5.3.2 Nairobi River

As the headwaters for the Nairobi River, Ondiri Swamp is critical to the capital's water supply.

3.5.3.3 Characteristics of the Athi basin

The table below gives a summary of characteristics of Athi basin

Table 3. 18: Characteristics of the Athi Basin

Basin and Basin area (sq. km.)	Major wetlands	Major land /wetlands uses	Pressures	Impacts
Athi 67 337km^2	• Athi River • Ramisi River • Nairobi River • Lake Amboseli	• Wildlife conservation area- (Nairobi National Park, Amboseli, Tsavo East and Tsavo West, Shimba Hills) • Industrial use • Farming- subsistence and commercial Pastoralism • Livestock ranching • Mining- sand, limestone • Fishing • Forestry • Energy- wind and thermal water supply • Nature conservation and • recreation • Irrigation • Sand harvesting • Salt harvesting • Dry season grazing • Cultural and spiritual use • Watering points for livestock • Waste water treatment	• Over-exploitation of surface and Ground water resources. • Wetlands resources degradation • Unregulated diversions of river channels • Catchment degradation due to overgrazing and sand harvesting. • Land use changes for settlement and agriculture • Climate change and variability	• Acute water scarcity due to high water demand • Limited ground water recharge • Changing river regime • Pollution of water resources from industrial effluents, and agricultural and domestic waste

3.6 Significance of wetlands within the programme area

Wetlands within the programme area play a fundamental ecological role and have potential as resources of great economic, cultural and scientific value. Among the critical values are:

(i) Wetlands provide critical habitats for a wide range of flora and fauna. Their biodiversity includes a large number of aquatic plants, fish, herbivores and avifauna of resident and migratory birds;
(ii) Wetlands are important sources of water for human consumption, agriculture and watering of livestock. They recharge wells and springs that are often the only source of water to some rural communities, for livestock watering and for wildlife support systems. The recharging of aquifers raises the water table making groundwater easily accessible. This has been the case along the Tana River corridor and in the Chyulu hills catchment area for Mzima springs and the Nol-Turesh water supply system.
(iii) Wetlands provide economic benefits through fisheries and generation of products such as fuelwood, building material, medicine, honey and various types of natural foods;
(iv) Wetlands are important grazing areas. They are the only sources of water and pasture/fodder for the pastoral communities during drought in the ASALs;
(v) Wetlands serve a wide variety of ecosystem functions including flood control, water purification, shoreline stabilization and sequestration of carbon dioxide;
(vi) Wetlands are areas of great scenic beauty. They are a tourist attraction, form important recreation sites for game and birds watching, swimming, photography and sailing;
(vii) Wetlands have great potential for multiple uses (including agricultural) so long as precautionary measures are taken for sustainable development.

3.7 National Parks and game Reserves

There are a number of national parks and game reserves within the project area that act as habitats of wildlife. The parks contain a wide range of landscapes from the mountain peaks that rise to 14,000 feet (4,300 m) above sea level, to their deep, v-shaped valleys intersected by streams, rivers, and waterfalls. The tables below gives a summary of national parks and game reserves found within the programme area.

Table 3. 19: Summary of National Parks within the programme area

No	National Parks	County	Area Km^2
1	Nairobi	Nairobi	117
2	Tsavo East	Taita Taveta-Kitui	4,682
3	Tsavo West	Taita Taveta	9065
4	Mount Kenya	Nyeri/Meru/Kirinyaga/ Embu	715.0
5	Aberdare	Nyeri/ Muranga	765.7
6	Meru	Meru	870
7	Ol Donyo Sabuk	Machakos	18
8	Malindi Marine	Kilifi	6
9	Watamu Marine	Kilifi	10

10	Amboseli	Kajiado	392
11	Kisite Marine	Kwale	28
12	Chyulu	Machakos	736
13	Mombasa Marine	Mombasa	10
14	Kora	Tana River	1787
15	Arabuko Sokoke	Kilifi	6

Table 3. 20: Summary of Game Reserves within the programme area

No	Game Reserve	County	Area Km^2
1	Malindi Watamu (Marine)	Kilifi	213
2	Watamu Marine	Kilifi	32
3	Shimba Hills	Kwale	192
4	Arawale	Garissa	533
5	Mwea	Embu	68
6	Rahole	Garissa	1270
7	Tana Primate River	Tana River	169
8	Boni	Garissa	1339
9	Losai	Marsabit	1806
10	Dodori	Lamu	877
11	Mpunguti Marine	Kwale	11
12	South Kitui	Kitui	1133
13	North Kitui	Kitui	745
14	Kiunga Marine	Lamu	250
15	Mombasa Marine	Mombasa	200
16	Maralal Sanctuary	Samburu	5
17	Ngai Ndethia	Machakos	212
18	Tsavo Road And Railway	Taita Taveta	112

3.8 Flora and fauna within programme area

Animals within the programme area are confined to national parks and game reserves and ventures outside only during dry seasons. The table below gives a summary of wildlife within the programme area

Table 3. 21: Wildlife within the programme area

National Park/ Game Reserve	Wildlife
Amboseli National Park	Amboseli National Park is home to many wildlife species, including the African elephant, Cape buffalo, impala, lion, cheetah, spotted hyena, giraffe, zebra and wildebeest among other African animals. There is also a host of Kenyan birds, both large and small.

Aberdare National Park	Animals easily observed in the park include the leopard, African elephant, African hunting dog, giant forest hog, bushbuck, mountain reedbuck, waterbuck, cape buffalo, suni, side-stripped jackal, eland, duikers olive baboon, black and white colobus monkey, and sykes monkey. Rarer sightings include those of the golden cat and the bongo - an elusive forest antelope that lives in the bamboo forest. Animals like the eland and spotted and melanistic serval cats can be found higher up in the moorlands. The Aberdare National Park also contains a large population of the black rhino. There are over 250 species of birds in the park, including the endangered Aberdare cisticola, Jackson's francolin, sparry hawk, goshawks, eagles, sunbirds and plovers.
Arabuko Sokoke National Park	The Arabuko-Sokoke Forest protects many endemic and near endemic species. The Clark's weaver is completely endemic to the forest, while the emonymous Sokoke scops owl, Sokoke pipit and the Amani sunbird and spotted ground thrush are found only here and in a forest fragment in Tanzania. The park adjoins Mida Creek, a mangrove forest that is an important shorebird wintering ground, protecting species such as the Terek sandpiper and the crab plover. The endearing golden-rumped elephant shrew, an endemic elephant shrew the size of a rabbit, is the most noticeable of the park's endemic mammals; the Sokoke bushy-tailed mongoose and Ader's duiker (found only here and in Zanzibar) are more elusive. The forest also has savannah elephants, African civets, as well as sokokes, baboons, and vervet monkeys. The park is also recognised as an outstanding centre of amphibian diversity.
Chyulu Hills	Mammals found in the hills include the eastern black rhinoceros (Diceros bicornis michaeli) buffalo, bushbuck, eland, African bush elephant, bushpig, Masai giraffe, African leopard, Masai lion, mountain reedbuck, steenbok, wildebeest, and Grant's zebra. The East african cheetahs are found at the plains of Chyulu Hills. Various snakes inhabit the hills, like black mamba, puff adder and rock python
Kisite-Mpunguti Marine National Park	Marine life is in abundance, including trigger fish, moray eels, angelfish, butterfly fish, groupers, parrotfish, wrasses, scorpionfish, puffer fish, damselfish, rays, snappers, green sea turtles, hawksbill turtles and dolphins. Humpback whales and whale sharks are seasonal.
Malindi Marine National Park	The park's attractions include coral reefs, tropical fish, barracuda, turtles and dolphins.
Meru National Park	The park has a wide range of wild animals including the African bush elephant, Masai lion, African leopard, Tanzanian cheetah, eastern black rhinoceros, southern white rhinoceros, Gravy's zebra, and hippopotamus.
Mombasa Marine National Park and Reserve	It has coral reefs in its waters.
Mount Kenya National Park	At lower altitudes Black and white colubus, other monkeys and Cape

	buffalo are prevalent.
Nairobi National Park	The park has a large and diverse wildlife population. Species found in the park include African buffalo, baboon, Eastern black rhinoceros, Grant's zebra, Tanzanian cheetah, Coke's hartebeest, Grant's gazelle, hippopotamus, African leopard, Masai lion, Thomson's gazelle, eland, impala, Masai giraffe, ostrich, vulture, Jackal, Warthog, Kongonies, Maribu Stalks and waterbuck. Herbivores, including wildebeest and zebra, use the Kitengela conservation area and migration corridor to the south of the park to reach the Athi-Kapiti plains. They disperse over the plains in the wet season and return to the park in the dry season. The concentration of wildlife in the park is greatest in the dry season, when areas outside the park have dried up. Small dams built along the Mbagathi River give the park more water resources than these outside areas. They attract water dependent herbivores during the dry season. The park has a high diversity of bird species, with up to 500 permanent and migratory species in the park. Dams have created a man-made habitat for birds and aquatic species.
Tsavo East National Park	Mammals A comprehensive list of the animal types found in Tsavo East Park includes the aardwolf, yellow baboon, bat, cape buffalo, bushbaby, bushbuck, caracal, african wild cat, Tanzanian cheetah, African Civet, dik dik, African hunting dog, African dormouse, Blue Duiker, bush duiker, red duiker, eland, African elephant, bat eared fox, greater galago, gazelle, large spotted Genet, small spotted genet, gerenuk, giraffe, African hare, springhare, Coke's hartebeest, hunter hartebeest, East African hedgehog, spotted hyena, stripped hyena, rock hyrax, impala, black backed jackal, tree hyrax, side stripped jackal, klipspringer, Lesser kudu, leopard, lion, banded mangoose, dwarf mangoose, Egyptian mangoose, Marsh mangoose, slender mangoose, white tailed mangoose, black faced vervet monkey, Syke's monkey, fringe eared oryx, clawless otter, ground pangolin, crested porcupine, cane rat, giant rat, naked mole rat, ratel, bohor, reedbuck, black rhinoceros, serval porcupine, serval, spectacled elephant shrew, bush squirrel, , East African red squirrel, striped ground squirrel, unstriped ground squirrel, suni, warthog, waterbuck, common zebra and Grevy's zebra. Birds Over 500 bird species have been recorded in the area, including ostriches, kestrels, buzzards, starlings, weaver birds, kingfishers, hornbills, secretary birds and herons.
Watamu Marine National Park	The park's coral reefs form the physical and biological backbone of the area. With over 150 species of hard and soft corals, such as brain corals, fan corals and sponges, it provides for abundant nutrients for

	fish. The main park has over 500 species of fish and the reserve over 1000. There are also whale sharks, manta rays, octopus and barracuda as some of the larger species in the park. Watamu also has different species of turtles and a turtle watch program which has managed to secure the main park's beach as a 99% viable sea turtle nesting site for endangered sea turtles. This beach is patrolled and monitored vigorously. The turtles nesting in Watamu include the Green, Hawksbill, and Olive Ridley turtles. The Olive Ridley species is rare but occasionally comes to the nesting site. Leatherback turtles do not nest in Watamu or Malindi but they pass by through the nearby waters during their migration.
Arawale National Reserve	The reserve is a critical refuge for a range of wildlife species including four globally threatened species: hirola, Grevy's zebra, East African wild dog, and East African cheetah. A study commissioned by Terra Nuova in 2006 also showed signs of presence of the African bush elephant.
Boni National Reserve	Wildlife Common herbivores in the region include hippopotamus, bushpig, warthog, buffalo, common duiker, topi and waterbuck. Common carnivores in the reserve are the vulnerable African wild dog and the aardwolf. Although extremely rare, African elephants are also present in the reserve. Birds As part of the East African coastal forest, it is likely to hold bird species characteristic of the coastal forests of eastern Africa possibly including globally threatened species such as Sokoke pipit.
Dodori National Reserve	Dodori National Reserve is a protected area located in Lamu East District of Coast Province in Kenya. It encompasses an important woodland and forest area that historically supported large populations of wildlife, including elephants, lions, buffaloes, and coastal topi.

3.9 Water resources environmental related issues

3.9.1 General

This SEA study analyzed and prioritized water resources' environmental related problems in the Tana and Athi Rivers basins. The study found that the problems identified mostly cut across counties within the basins. The dual effect of human influences and often fragile ecosystems has resulted in a deterioration of the basins' ecosystems. The functioning of wetlands, riverine habitats, the catchment area and groundwater are impaired virtually throughout the project area. This has led to socio-economic consequences related to the loss of goods, services and opportunities that these ecosystems would otherwise provide. The SEA study was developed around four broad environmental related priority areas of concern identified in the two basins as follows:-

- Increasing water demand
- Declining water resources quality
- Changes to the hydrological regime
- Land degradation.

There is no hierarchy of severity of the four priority areas of concern that need to be addressed prior to implementation of the NIB programmes as each is evident at different degrees of scale and severity in the basins. Therefore, in terms of importance to the SEA study, all four areas are treated equally as far as their relevance to the basins as a whole is concerned. Where differences in scale and severity occur, prioritization is made at individual basin-level/ and or county level through proposed mitigation measures and through suggested alternatives to individual projects under the NIB programmes.

3.9.2 Increasing Water Demand

The volume of the available surface water for Tana and Athi rivers is estimated at 5,858 mcm/ year and 1,198 mcm/ year respectively. In the Tana River for instance, water is abstracted in the upper zone largely for irrigation, domestic and urban use and for livestock farming. Water abstraction during the dry season has been noted to stress most of the rivers in the two basins. For instance, during dry season, some previously perennial rivers like Thanantu are drying up downstream. This has been attributed to over abstraction by irrigators upstream. Increasing the usable yield from the river systems to meet increasing demand will require not only extensive expenditure on infrastructure but a deliberate capacity building and awareness creation to irrigators on the need for efficient water resources management.

As the easy (and less costly) options have already been used, demand-side interventions, such as water conservation, demand management, re-use of water, water storage, rainwater harvesting, etc. need to be further explored and implemented through an integrated water resources management approach. The increased level of cultivation of high value crops using irrigation water in the upper zone of Tana basin has seen an increase in the number of farmers as well as acreage under irrigation. There is an increase in irrigation groups all seeking permits to develop their own water intake along already strained rivers. For instance River Sagana has over 60 intakes in the upper zone alone and more applicants are lining up to get abstraction permits. Similarly, most of the rivers in Murang'a County are stressed especially during dry seasons. These include North and South Mathioya, Maragua, Saba Saba and Irati among others.

In the face of increasing demand, the ecosystems within the Tana and Athi River basins are at risk. This is aggravated by inadequate knowledge of flows and a deteriorating monitoring system. This applies to an even greater extent to groundwater. Cross-cutting issues related to water supply that contribute to the problem are:

- Inefficient water use across most (all) water-use sectors;
- Losses of water due to poor maintenance and aging infrastructure;
- Deteriorating water quality
- A limited appreciation of the value of water among many users; and

- Insufficient demand-management interventions and incentives to use less water particularly for irrigation in the upper zones.

Plate 2: Irrigation infrastructure at Wikithuki Irrigation project, Kitui County

3.9.3 Declining water resources quality

The key water quality issues in the Athi River basin have been identified as: nutrient enrichment - primarily linked to increased phosphorus and nitrogen concentrations; microbial contamination from urban settlements and poorly operated sewage treatment works; and changes in sediment load. Although a common problem throughout the Athi River basin, pollution and declining water quality is most severe in parts of the river and tributaries close to Nairobi City and the industrial towns of Thika and Athi River. At a time when the types and sources of pollution are increasing, reduced volumes of water in the basin prevent their effective dilution, compounding the problem of deteriorating quality of water resources.

Plate 3: Eutrophication in parts of Athi river Basin near Kathimani area

The problem can be largely attributed to certain cross-cutting issues including among others lack of sewerage treatment system particularly in the upcoming new human settlements while the existing sewerage system are old and not designed to handle a fast growing human population; mushrooming informal settlements along river systems with poor or no waste management infrastructure; lack of environmental awareness and lack of incentives to adopt best practices; aging and poorly maintained infrastructure; limited monitoring and ineffective enforcement of compliance. In the Tana basin, the major water quality issue relate to siltation and sedimentation as a result of slope cultivation, riparian area cultivation and quarrying near river banks. Stone quarrying is common in Meru, Nyeri, Embu, Kirinyaga and parts of Murang'a Counties. Key elements related to declining water resources quality include:

- Eutrophication;
- Increased salinity and sodicity of soils and water;
- Inadequate systematic monitoring of surface and subsurface water quality;
- High cost of appropriate pollution control;
- Lack of knowledge, capacity and awareness related to pollutants and appropriate measures to deal with them;
- Increased costs related to water treatment;
- Health risks; and
- Lack of a basin-wide accident and pollution warning system.

3.9.4 Changes to the hydrological regime

Changes to the hydrological regime occur as a result of intensive and extensive upstream development changing the environmental status of the hydrological system within the catchments. The hydrological regimes of Tana and Athi rivers have changed significantly over time. Apart from the mean annual runoff being reduced to half, the estimated natural flow has significantly changed and the pattern of flow is different to that of the natural river in an environment which is not degraded. There is less variability in flow from one year to the next and, within the year, there is a less distinct seasonal pattern. The frequency of smaller floods has also been reduced, with most being absorbed by upstream abstraction and storage. Thanantu River which for a long time has been a perennial river is changing and during dry season parts of downstream of the river becomes a dry river bed.

Plate 4: Dry parts of Thanantu River at Katonga area, Tharaka Nithi County

In Athi River, there is less water in the system to dilute increasing volumes of polluted water. . The volume of the river has significantly reduced and patterns of flow altered. These changes in the hydrological regime of the river impact downstream ecosystems, including the alga bloom witnessed in parts of the Athi River particularly in Machakos and Makueni Counties. Environmental flow requirements need to be adequately addressed. The changes in hydrological regime can be attributed to storage and release or transfer of water to meet significant demands at areas and times when water would otherwise not be available. In assuring that these demands are met, disruption of the natural flow of the river compromises the integrity of downstream aquatic ecosystems and environmental services they provide. The quality of water resources deteriorates and pests and invasive species increase. By providing opportunities in some

areas by assuring water supply, other options and potential opportunities are lost, especially those reliant on healthy wetland habitats and natural resources related to them. In addition, direct costs related to water treatment, environmental management and disease control increases.

3.9.5 Land degradation

According to the WHO, land degradation is caused by multiple forces, including extreme weather conditions particularly drought, and human activities that pollute or degrade the quality of soils and land utility hence negatively affecting food production, livelihoods, and the production and provision of other ecosystem goods and services. Land degradation has accelerated during the 21st Century due to increasing and combined pressures of agricultural and livestock production (over-cultivation, overgrazing, forest conversion), urbanization, deforestation, and extreme weather events such as droughts and coastal surges which salinate land. Desertification, is a form of land degradation, by which fertile land becomes desert. Inadequate land management associated mostly with agriculture and quarrying in parts of Tana and Athi River basins have led to loss of wetland storage and aquifer recharge capacities; increased sediment loads in the rivers; deteriorating quality of water resources; increased distribution and abundance of alien invasive plants; loss of biodiversity and diminished land productivity. At a time when land sub division into smaller pieces is rampant, farmers are faced with the possibility of the land being less productive. In some parts of the programme area, livestock production is in decline, and opportunities for community-based management of natural resources and alternative livelihood options are inadequately considered.

Plate 5: Land degradation due to sheet erosion in parts of Meru county

Land degradation is generally perceived to be a problem in the Tana and Athi basins and the middle and lower zones are the hardest hit. Land degradation is as a result of de-vegetation and deforestation, over-grazing, sheet and wind erosion as well as prolonged droughts in and out of season that devastate vegetation. Kitui, Garissa, Tana River, Machakos, Kajiado, Muranga, Embu, Tharaka Nithi and Meru are some of the counties experiencing effects of land degradation. The problem is driven by a number of underlying factors related to a lack of integrated planning, insufficient understanding of ecosystems, inadequate policy harmonization, limited alternative livelihood options, population pressures, land tenure, contradictory statutory and traditional rules and poor rehabilitation practices in construction and mining industries. A conflict of interest between interventions aimed at poverty eradication and ecosystem health is a common issue in most of the counties in the two basins. Key elements to this problem include:

- Loss of land and infrastructure due to erosion;
- Decreased wetland storage potential;
- Reduced groundwater recharge;
- Reduced water quality in rivers and reservoirs;
- Increased abundance of alien invasive plants;
- Decreased potential for land productivity; and
- Poor coordination and lack of integration between development, and water and environmental sectors.

It is however worth noting that some WRUAs in Meru, Embu, Kirinyaga and Murang'a Counties have started putting up initiatives to reclaim wetlands as well as demarcate riparian areas.

3.10 Irrigation Farming

There are a number of completed irrigation projects in the Tana basin. These are composed of smallholder, public and private irrigation schemes. Under the smallholder category, smallholder farmers are organized into Irrigation Water Users Associations (IWUAs) and own, operate and manage irrigation infrastructure. In the Tana Basin, there are about 30,300 hectares of land under smallholder irrigation projects such as Tagwa Maragima, Thung'ari, Mia Chake, Kirurumwe and many others. The public irrigation projects are categorized as GoK funded, CDF funded and donor funded projects.

Compared to the lower Tana, smallholder irrigation in the upper Tana is well established and vibrant with marketing systems and financial support for group-based smallholder irrigations schemes. Public irrigation schemes are developed and centrally managed by the government through agencies such as NIB. Some of the projects that fall under the Tana basin and are under management of NIB include Mwea, Hola and Bura irrigation schemes. The table below shows public irrigation schemes within the study area.

Table 3. 22: Public Irrigation Schemes

Project	County	Current irrigated area	Total area with Expansion (Ha)
Mwea	Kirinyaga	8,100	11,600
Hola	Tana River	1,900	6,900

Bura	Tana River	2,500	5,500

Source: Environmental Audit Reports for Mwea, Hola and Bura Schemes, 2015.

Private individuals and companies are also active in carrying out irrigated farming in the basin. Individuals operate small acreages (often less than 2 acres) while companies such as Delmonte and Kakuzi among others partially irrigated coffee plantations in Kiambu County and operate large commercial farms. In total, the large companies manage about 28,167 hectares of irrigated land. Meru, Embu, Nyeri and Tharaka Nithi have a substantial number of existing irrigation projects compared to counties like Tana River, Kitui and Lamu. Throughout the Tana basin, horticulture is produced together with food crops such as maize. However, in the upper parts of Tana, horticultural crops such as tomatoes, kales, French beans etc. dominate. Counties in these parts include Nyeri, Murang'a, Kirinyaga, Embu and Meru.

In the lower parts of the Tana, food crops such as maize are produced, while horticultural crops are mainly vegetables and fruits. Almost all of the projects abstract water directly from either the rivers that drain into the Tana River or the Tana River itself. It is important to note that water shortages in the Upper Tana is constraining further irrigation development, and the already developed areas are not fully utilized; this calls for investment in water storage structures and efficient irrigation technologies. In addition, most old projects require rehabilitation. Other challenges include weak IWUAs and limited technical staff in the Ministry of Water and Irrigation. Irrigation projects in the basin are characterized into completed and operational projects, projects under construction and planned projects.

3.11 Irrigation Water Sources

The major water towers in the Tana River basin are the Aberdare ranges, Nyambene Hills and Mount Kenya. Most of the irrigation projects in upper Tana abstract their water from Tana River and its tributaries. The major rivers and streams that form the Tana Basin include: Thika, Chania, Nairobi, Gura, Thiba, Maragua, Mathioya North and South, Nyamindi, Rupingazi, Ena, Thuchi, Ruguti, Tungu, Nithi, South Maara, North Maara, Mutonga, Kathita and Sagana. All the irrigation projects in Tana River basins depend on these rivers for irrigation water. Majority of the farmers do not harvest rain water for irrigation but rather for domestic purposes.

3.12 Irrigation Water Conservation Methods currently in use

There are no effective irrigation water conservation methods currently in use in Tana River basin. Most of the farmers along the Tana basin do not apply water as per the irrigation system design. This situation leads to overwatering of crops without putting in mind the crop water requirement. For instance, in Muringa banana irrigation projects in Meru County, farmers water their banana crops throughout the day and night thus over-saturating the ground with water. This is not only harmful to the crop but also weakens the stability of the ground as it is soaked most of the times. In most of the counties, there are no irrigation water harvesting structures, such as dams to store flood water during rainy season. Stakeholders in Tana basin are proposing construction of dams and/or water pans to tap flood water. For instance, in Sagana irrigation project in Nyeri County, there are plans to construct a reservoir within Kahiti swamps in Gonio area to tap

flood water and use the same for irrigation purposes during dry spell. It was also noted that farmers in the area have invaded riparian areas as well as wetlands turning them into farm lands.

The main irrigation methods along the Tana Basin are furrow/ canal and use of overhead sprinkler irrigation. These methods are generally wasteful and not economical in terms of conserving water. There is therefore need to train farmers on proper water management through adoption of efficient irrigation methods that conserve water such as drip irrigation. In spite of agroforestry taking root in the upper Tana courtesy of programmes like MKEPP and UTaNRMP, there is still poor catchment conservation and management. There is rampant felling of trees in the interior parts of the main water towers as well as hilltop and slope cultivation.

3.13 Constraints to irrigated farming

During our SEA study, the team engaged with irrigation officials and other key stakeholders at County levels. Below we highlight some of the constraints identified during study team's meetings with the various stakeholders.

(i) Lack of organized group marketing of farm produce;
(ii) Poor infrastructure especially road network which leads to high cost of transporting farm produce;
(iii) Lack of accessibility to market information;
(iv) Poor storage facilities which leads to perishability of farm produce. Horticultural crops such as avocadoes, pineapples and bananas are perishable and need to be delivered to the market on time to fetch good prices but farmers channel their produce through middlemen who pay them low prices; and
(v) The inability of small scale farmers to form strong co-operative societies which has led to middlemen exploiting their situation and offering low prices for their produce.

3.14 Farming System

The farming system in the Tana basin is predominantly mixed farming and an important feature to note is that the average farm size is 0.2 - 0.8 ha per household. Livestock farming includes cows, sheep, donkeys, goats and chicken. Livestock husbandry is largely for meat, milk and for ploughing and carrying loads. Fish rearing is not a major economic activity in the catchment. For the large part of the population who practice mixed farming, food crops such as maize, beans and potatoes are predominant. Aforestation and agro forestry is also part of the farming system. The system is determined by climate, altitude, soil types, soil fertility and the social and economic characteristics. To a large extent, farmers grow crop species that maximize profits. Coffee, for example, is being substituted with horticultural crops while dairy farming is gaining ground in many parts of the catchment. Notably dairy farming pays farmers well more frequently. Livestock is reared through zero grazing in the upper and middle zones, whereas in the lower zones free range is the preferred method. It was noted that on average farmers are engaging in various technologies as follows: aquaculture, apiculture, improved chicken rearing, rabbits, piggeries, dairy goats, tree farming and commercial fruit.

3.15 Crop Types

Throughout the Tana basin, horticulture is produced together with food crops such as maize. However, in the upper parts of Tana basin, horticultural crops such as tomatoes, kales, French beans etc dominate. In the lower parts of the basin, food crops such as maize are produced, while horticultural crops are mainly vegetables and fruits.

3.16 Present farming practices

In the upper parts of the Tana River Basin, smallholder agricultural producers grow crops under rain-fed condition, with some under irrigation. The table below gives summary of present farming practices within the programme area.

Table 3. 23: Present farming practices

Land preparation	Land preparation is mainly carried out by manually with very few incidences of mechanized farming especially in the tea and coffee zones where tractors are used. Oxen are also used in ploughing in some places.
Planting	Planting is mainly done by hand for all the crops. Most of the horticultural crops and fruit crops are first grown in the nursery after which they are transplanted to the fields.
Weeding	Weeding is mainly done by hand using hoes or jembes and there are usually two weeding sessions per growing season. First weeding is 2-3 weeks after germination and the second weeding is just before flowering.
Harvesting	Harvesting of crops is not mechanized and so manual harvesting is dominant.
Application of farm inputs	Fertilizers, chemical for pests, disease and weed control are used. Sprayers are used to spray chemicals.

3.17 Soil and water conservation:

According to upper Tana catchment baseline survey of 2014, there are various soil and water conservation measures practiced within all the river basins which range from agronomic, vegetative, physical and overall management. Agronomic practices include plant and soil cover, conservation farming methods and contour farming. Vegetative measures include plant barriers (vegetative strips), live fences and windbreaks which are common in Kirinyaga and Meru Counties. Physical soil and water conservation structures involve construction of terraces, fanya juu, banks bunds, cut off and retention ditches, drains and barriers. Nappier grass is used to stabilize the soil and water conservation structures, while grass strips are also planted along contours. Overall management involves area closures, and selective clearing which is common in lower zones along Rupingazi River basin where farmers have huge tracts of land.

3.18 Constraints to Crop production

- High cost of inputs;
- Inadequate skills in farming;
- Low prices of farm produce;

- Soil erosion and declining soil fertility
- Lack of organized marketing structures;
- Poor marketing channels for farm produce;
- Impassable roads during the rainy season;
- Pests and diseases; and
- Shortage of storage facilities after harvest.

The table below gives a summary of crop pests within the programme area, crops attacked by the pests and control measures put in place by farmers to manage the pests.

Table 3. 24: Crop pests within the programme area

Crop pests	Crop attacked	Control measure by farmers
1. Bollworms	Cotton	Chemical control.
2. Maize stalk borer.	Maize, sorghum, sugar cane	Bulldock
3. Aphid.	Pulses, cotton, vegetables	Karate, cyclone
4. Cutworms.	Field crops	-
5. Wildlife	Field crops	Guarding
6. Cotton Steiner	Cotton	Chemical control
7. Cotton aphids	Cotton	Chemical control
8. Weevils	Stored maize, beans	Chemical control
9. Rhino beetle	Coconut	-Chemical control -Bush clearing -Handpicking
10.Red spider mite	green grams and tomatoes	Chemical control

The table below gives a summary of crop diseases within the programme area, crops attacked by the diseases and control measures put in place by farmers to manage the diseases.

Table 3. 25: Crop diseases

Crop	Disease	Remarks
Cereal and pulses (produce)	GGB, weevils	Actellic, sphincter dust
Bananas	Nematodes	Nematocides, nemacur
Bananas	Cigar end rot	Field hygiene
Bananas	Panama disease	Field hygiene, roughing
Tomatoes	Damping off	Use clean seed
Tomatoes	Early blight	Use fungicide
Tomato	Bacterial wilt	Use fungicide
Vegetable and field crops	Root rot	Use fungicide
Tomato	Leaf spot	Use fungicide

3.19 Farm Inputs Use and Application

3.19.1 Input supply

Most of the farmers get their input supplies from local trading centres and agrochemical outlets. Source of labour is from family labour or hired skilled or unskilled labour.

3.19.2 Input Utilization

The farm inputs used in farm production include agro-chemicals, hand held equipment, feeds, seeds and labour. Majority of farmers in Tana River basin use modern inputs but complained of high cost of farm inputs.

3.19.3 Certified seeds

According to upper Tana baseline survey 2014, the percentage of farmers using improved or certified seeds in the counties was fairly high. Certified seeds were mainly used for maize growing and for horticultural use. The use of certified seeds was highly noted along Nairobi and Nyamindi river basins. The main certified seeds generally preferred are maize, bananas, sorghum, cowpeas, tomatoes and kales. The certified seeds used in Nairobi River were mainly maize, beans and kales, whereas for Nyamindi they were maize, beans, green vegetables and tomatoes.

Along the Thanantu river basin there was less use of certified seeds ostensibly because soils are fertile in the upper ecological zone. This lack of awareness resulted in low use of certified seeds as farmers thought this was not necessary due to the higher soil fertility. In the lower zone, which is mainly dry land, farmers are inclined towards growing sorghum and cowpeas and thus they mainly use seeds preserved from previous harvests.

In Kitui County, Kenya Agricultural Research Institute plays a great role in providing clean certified planting materials for the sorghum crop. (Kitui County Integrated Development Plan 2013-2017). In Tana delta, there was less use of certified seeds due to low availability in local stockists.

3.19.4 Use of Agricultural inputs

Some farmers interviewed complained of high cost of agricultural inputs. The per-unit costs of agricultural production inputs such as feed, fertilizers, agro chemicals and seed varied widely due to production systems in the whole catchment. Crop chemicals such as herbicides, insecticides, and fungicides are applied on an "as-needed" basis and applications vary widely from farm-to-farm, and from crop-to-crop. Seed costs varied based on conventional or biotech varieties. In addition to land, machinery, fertilizer, crop chemicals, and seeds, farmers face costs for buildings, grain handling facilities, hired labor, fuel for vehicles, heating, and conditioning crops, livestock feed and veterinary care for livestock.

3.19.5 Fertilizers

According to a report by Kenya Horticulture Competitiveness Programme (Grow Kenya July 2013, Issue No. 34) farmers tend to use fertilizer in wet and rainy areas than in dry areas, due to production risks associated with dry seasons. Adequate rainfall stimulates crops to respond favourably to fertilizer and farmers tend to get certified seeds or better varieties to increase yields during this season. In dry areas or where water supply is inadequate, crops do not respond favorably and fertilizers may actually harm or burn the crop. The use of fertilizers is fairly high in Tana River catchment. Popular brands locally are DAP, Urea, SA, MAP and CAN. These fertilizers are sourced at subsidized rates from the NCPB depots within the catchment and also from the local agro-chemical outlets. The greatest limitation here has been the cost of transportation of these fertilizers.

3.19.6 Pesticides

Majority of farmers use pesticides to control pests and diseases. The common insecticides used for pest control on rice is Supersumithion and Furadan while those used for vegetable crops are Selecron, Ambush, Karate, Cyclone, Dimethoate and Polytrin, Thurud, Duduthrin and Bulldock. Fungicides commonly used are Dithane Green copper and Cercobin. Knowledge of the quantity of pesticides used varied considerably by crop and season.

3.20 Agro-Economy

3.20.1 Marketing outlets

The market for food crops within all the River Basins is basically the local market, where it is bought by locals or middle men and sold to the tertiary market. Cash crops which are mainly tea and coffee are sold to processing factories within localities where farmers are members. Over 80% of the farmers are primary producers, selling their crops and livestock products at the farm gates. In most shopping centers, most of them are not well equipped with facilities for bulk storage and cold storage rooms for perishables.

3.20.2 Producer prices

Horticultural crops, maize, beans, cowpeas, green grams, sorghum, cassava, sweet potatoes, and bananas depend on weekly markets where prices vary according to supply and demand of the products. Most of the commodities in all counties within the programme area are sold in raw form without any value addition thereby fetching low prices in the market. There is also poor market organization which has led to very low prices.

3.20.3 Marketing constraints

- Lack of organized group marketing of farm produce;
- Poor infrastructure especially road network which leads to high cost transportation of farm produce;
- Lack of accessibility to market information; and
- Poor storage facilities which leads to perishability of farm produce.

3.21 Existing Agriculture Support Services and Infrastructure

In all counties within the programme area, there is need to improve efficiency and effectiveness in extension services delivery to farmers and pastoralists. The capacity of the extension staff need to be increased in order to improve service delivery. In all the counties within Tana River catchment, farmers complained of lack of regular visits by the agricultural officers to offer extension services.

3.21.1 Research

There is need to improve efficiency and effectiveness in research institutions within the programme area. The following stakeholders are responsible for research:

Table 3. 26: Stakeholders responsible for agricultural research

Institution	Responsibility
National irrigation board (NIB)	The National Irrigation Board (NIB) is a government Parastatal established in 1966 by an Act of parliament, Chapter 347 of the Laws of Kenya, and whose mandate is the development, promotion and management of all national irrigation schemes in the country. NIB has research stations in Mwea Irrigation Agricultural Development Centre, Hola Irrigation Research Station and Bura Irrigation Research Station.
Kenya Agricultural and Livestock Research Organisation (KALRO)	The Kenya Agricultural and Livestock Research Organisation (KALRO) is the premier national institution bringing together research programs in food crops, horticultural and industrial crops, livestock and range management, land and water management, and socio-economics. KALRO promotes sound agricultural research, technology generation and dissemination for food security through improved productivity and environmental conservation.
Tana and Athi Rivers Development Authority (TARDA)	Information regarding this River Basin Organisation (RBO) is given by TARDA (TARDA 2006), including contact names, basin details, authorities, structures, responsibilities and associated ministries. The main objectives of RBO include: flood control, water scarcity regulation, water conflict regulation, river regulation and water resource planning and development.

3.21.2 Extension

There is need to improve efficiency and effectiveness in extension services delivery to farmers and pastoralists within the programme area. The capacity of the extension staff need to be increased in order to improve service delivery. There are inadequate extension services provided to farmers in the catchment. The following institutions are responsible for offering agricultural extension services:

Table 3. 27: Stakeholders responsible for agricultural extension

Institution	Responsibility
Ministry of Water and Irrigation	The departments of water and irrigation under this ministry ensure

(county level)	conservation of water and improvement of agriculture through designing and support of irrigation systems.
Ministry of Agriculture (county level)	The National Agriculture and Livestock Extension Programme (NALEP) is the main government extension program. It is implemented by the Ministry of Agriculture and supported by the government (NALEP-Gok) and Swedish International Development Agency (NALEP-Sida). It ensures provision of extension services to farmers and adoption of new and innovative ways of farming. It supports plant and animal disease control and management and monitoring activities of livestock sale yards and sale of other animal products
Farmers' Cooperative Societies	They provide market for farmers' products at good prices.
Kenya Veterinary Association (KVA)	It carries out mass vaccination against animal diseases; organize field days and scientific conferences.

3.21.3 Credit to Farmers

Most farmers can access credit from a variety of financial institutions including commercial banks, micro-finance institutions and savings and credit organizations situated in urban centres within the programme area. All the available financial institutions give credit to farmers. The major challenge is not the access of credit but the conditions for accessing the same and difficulties in repayment. The conditions for accessing credit are mainly collateral, savings, security for instance in terms of land title deeds and guarantors. Most people within the programme area have bank accounts and also most of the Self Help Groups practice table banking. Table banking or rotating savings and credit associations (Rascals) are mutual membership clubs registered as social welfare groups. The members pool resources which they lend to individual members in turns.

3.22 Mechanization and farm Machinery

Farming is generally rudimentary with very few incidences of mechanized farming especially in the tea and coffee zones. Tractors, sprays and irrigation pumps were the most common forms of mechanisation in use in the river basins. Farming is carried out by the use of hand held tools such as hand hoe, (chop-down-and-pull), fork jembes and pangas. The same technology is used in the growing of fruits and vegetables. Harvesting of crops is not mechanized and so manual harvesting is dominant.

In the drier areas, oxen are used to plough the land as holdings are larger. Weeding of gardens is sometimes achieved through the use of oxen ploughs and the use of family labour and occasionally the use of hired labour. The major tools that are used similarly include hand hoe, fork, jembes and pangas. Milking is largely accomplished through the use of manual labour. Milking through the use of machines is limited to large but few farms.

3.23 Post-harvest Product Handling and Processing

3.23.1 Harvesting

Within the programme area, harvesting of crops is not mechanized and so manual harvesting using hand is dominant.

3.23.2 Storage

The main storage facilities for cereals are granaries which are used by most small scale farmers while large scale farmers use the trader stores and National Cereals and Produce Board (NCPB) depots .Tea leaves and coffee berries are stored and processes in their respective factories. Over 80% of the farmers are primary producers, selling their crops and livestock products at the farm gates hence no storage is required

3.23.3 Post-harvest facilities and processing

There is inadequate post-harvest facilities and processing in all the river basins. Most shopping centers are not equipped with facilities for bulk storage and cold storage rooms for perishables like fish and vegetables.

3.23.4 Crop Processing and Value Addition

In upper Tana, there are few agro-processing industries, with the most common being for tea and coffee. There are also a few industries dealing with dairy products – milk cooling and processing. There is also a fish processing plant and a hatchery in the project area. In middle Tana there are processing industries for mango, maize and the farmers are involved in value addition for sisal. In lower Tana the common agro-processing industries are for maize, mango, rice, pawpaw, passion and groundnut. Challenges on agro-processing include:

- High startup capital;
- Exceptional hygienic conditions to meet licensing requirements;
- Insufficient transport to reach out farming groups effectively;
- Highly skilled labor required in some enterprises and;
- Unavailability of raw materials all year round which makes it a big challenge for factories or processing plants to break even.

CHAPTER 4

4.0 RELEVANT LEGISLATIVE FRAMEWORK AND RELATED PPP DOCUMENTS

4.1 Introduction

To successfully design and implement National Economic Programme and Expanded Irrigation Programme, it is significant that they are in line with legislative and regulatory framework applicable to them. Further, the programmes must fit within the government's and area development plans and goals. The following is a summary of relevant legislative framework applicable to the programmes under study.

4.2 National Plans and Policies

Table 4. 1: National Plans and Policies

Policy	Relevance to the Programmes
The Constitution of Kenya 2010 The Constitution of Kenya, 2010 provides the broad framework regulating all existence and development aspects of interest to the people of Kenya, and along which all national and sectoral legislative documents are drawn. In relation to the environment, article 42 of chapter four, The Bill of Rights, confers to every person the right to a clean and healthy environment, which includes the right to have the environment protected for the benefit of present and future generations through legislative measures, particularly those contemplated in Article 69; and to have obligations relating to the environment fulfilled under Article 70. Chapter 5 of the document provides the main pillars on which the environmental statutes are hinged.	In conformity with the Constitution of Kenya, every activity or project undertaken within the republic must be in tandem with the state's vision for the national environment as well as adherence to the right of every individual to a clean and healthy environment. The programme has various development activities that utilize sensitive components of the physical and natural environment and stakeholders involved in programme implementation should undertake to ensure that the principle of sustainable development is observed in all stages of projects associated with the programmes.
Agricultural Policy The key areas of concern of the policy include increasing agricultural productivity and incomes, especially for small-holder farmers; emphasis on irrigation to reduce over-reliance on rain-fed agriculture in the face of limited high potential agricultural land; encouraging diversification into non-traditional agricultural commodities and value addition to reduce vulnerability; enhancing the food security and a reduction in the number of those suffering from hunger.	The development objective of EIP and NEP is to increase Kenya's irrigated area through investments that are cost effective, environmentally and socially sound, and beneficial to the inhabitants of the project area. In addition, the programme aims to sustainably increase agricultural productivity and the expected overall project result includes "increase in value added per worker" and "increase in value added per hectare". All these are in line with Agricultural policy.
Vision 2030 and the First Medium Term Plan (2008 – 2012) The Vision encourages the development of an	The programmes recognise irrigation as a way of improving nutrition and livelihoods of the local people and this is in line with Vision 2030 and First Mid Term

agriculture sector that is "innovative, commercially-oriented and modern". The achievement of this vision is rested on five key strategic thrusts, namely reforming institutions, Increasing productivity through provision of widely accessible inputs and services, transforming land use, developing arid and semi-arid areas for both crops and livestock; and increasing market access through value addition. The Vision sets a goal of increasing the area under irrigation and to improve efficiency in irrigated production.	Plan. Development of irrigation projects within the Tana River basin has been identified as one of the Vision 2030 flagship projects under the water and drainage sector.
National Irrigation Master Plan The overall objective of the National Irrigation Master Plan is to identify and map out the irrigation and drainage potential and formulate irrigation and drainage sector master plan to guide and facilitate quick development of this potential in line with the country's Vision 2030. In most parts of the country, rainfall is inadequate to meet the crop water requirements during the dry seasons, and the river flows are generally at their lowest. Therefore, to tap the irrigation potential identified in the above section, irrigation water storage will be required. The specific strategies to be implemented in order to achieve the targets set include increase irrigation and drainage command areas, rehabilitation of existing irrigation and drainage command areas, increase crop yields in irrigation and drainage command areas, diversification of livelihood in irrigation and drainage command areas and enhance utilization of appropriate irrigation and drainage Technologies	Irrigation and drainage are major objectives of Expanded Irrigation Programme and National Economic Programme and this is in line with provisions of this Master Plan
National Irrigation and Drainage Development Policy The draft policy (MWI, 2009) seeks to stimulate irrigation development through targeted technical support, effective co-ordination of the sector, institutional reforms, and the enactment of a comprehensive legal framework for irrigation development. It intends to guide, coordinate and harmonize sustainable sector development. The policy with its corresponding instruments anchors strategic interventions and legal safeguards, which in turn support and fast track policy implementation for the growth and sustainability of irrigation, drainage and water storage in Kenya.	Irrigation development and expansion are key features of EIP and NEP. One of the objectives of EIP is to attain National Food Security in Kenya and eliminate hunger amongst Kenyans by developing 540,000 ha for irrigation in 5 major river basins.
The National Poverty Eradication Plan (NPEP) and the Poverty Reduction strategy Paper (PRSP) The National Poverty Eradication Plan has the objective of reducing the incidence of poverty in both rural and	The Programmes under consideration intend to address the contents of this paper by creating opportunities for people within Tana and Athi River basins for economic advancement. Poverty eradication through employment

urban areas by 50% by the year 2015, as well as strengthening the capabilities of the poor and vulnerable groups to earn income. It also aims to narrow gender and geographical disparities and create a healthy, better-educated and more productive population. This plan has been prepared in line with the goals and commitments of the world Summit for Social Development (WSSD) of 1995. The WSSD themes included poverty eradication, reduction of unemployment, and social integration of the disadvantaged people and the creation of an enabling economic political and cultural environment.	creation and irrigated agriculture is a key objective of the programmes.
Strategic Plan of the Irrigation, Drainage and Water Storage Department (IDWS) (MoWI) The Strategy for the Department of Irrigation, Drainage and Water Storage presents the strategic direction that the Ministry of Water and Irrigation intends to follow in the irrigation, drainage and water storage sector over the next five years. The purpose of the plan is to set the overall direction and activities in line with the changing socio-economic and political environments and resource availability. The plan highlights key issues in the Irrigation and Drainage (I&D) sub-sector, and identifies objectives and strategies to achieve the objectives. The plan estimates that with the adoption of water harvesting and storage technologies, the current irrigation potential could be increased by a further 800,000 hectares to 1.3 million hectares. With effective exploitation of ground water resources and innovative management of trans-boundary water resources, this potential could be increased further.	Optimal water use and management is a significant goal of the Expanded Irrigation Programme and National economic Programme. The main goal is to improve sustainability in agriculture and production through irrigation. Irrigation water storage is a key intervention under the programmes.
National Food Policy The Food Security and Nutrition Policy (FSNP) recognize the need for multi-public and private sector involvement, and that hunger reduction and nutrition improvement is a shared responsibility of all Kenyans. The policy and associated actions will remain dynamic to address contextual changes and changing conditions over time. Food security is defined as the physical and economic access to sufficient, safe and nutritious food by all people, at all times, to meet their dietary needs and food preferences for an active and healthy life.	The main objectives of the EIP and NEP is to achieve food security through modern farming practices under irrigated agriculture, an objective that is also central to National Food Policy
Agricultural Sector Development Strategy (ASDS), 2009-2020 The strategic vision of the ASDS is an agricultural sector	The strategy recognizes the significant potential for irrigation that remains unexploited, and the importance of irrigation in expansion of cultivated land to increase

that is innovative, commercially-oriented and modern as reflected in the Kenya Vision 2030. ASDS identifies the overall sector goal for the sector, which is to achieve an average growth rate of 7% per year over the next 5 years. Among the targets to be achieved to meet this growth rate include transforming land use to ensure better utilization of high and medium potential lands and developing arid and semi-arid lands (ASALs) for both crops and livestock; and	agricultural output and food security. It recognizes that irrigation can play an important role in increasing Kenya's agricultural productivity per unit of land, as well as expand arable land and stabilize agricultural production in times of adverse weather conditions. NEP and EIP intend to expand agricultural production to achieve food security objectives within the country.
National Land Policy of 2009 The policy recognizes that land is critical to the economic, social, and cultural development of Kenya and that the use of land in urban and rural areas as well as in the land/water interface has been a major area of concern to all Kenyans. Problems of rapid urbanization, inadequate land use planning; unsustainable production, poor environmental management, inappropriate ecosystem protection and management are commonplace and require appropriate policy responses. The policy further recognizes that land use planning is essential to the efficient and sustainable utilization and management of land and land based resources. To conserve and manage the environment, measures on conservation and sustainable management, ecosystem protection, urban environment management, environmental assessment and audits, shall be undertaken. The policy recognizes Environmental Assessment and Audit as Land Management Tools	The planning principles outlined in this policy should guide the process of implementation of the projects within the Programmes under study and public participation, a major component environmental assessment and audits should always be carried out to ensure that all stakeholders are aware of planned activities.
The National Environmental Action Plan (NEAP). The NEAP for Kenya was prepared in mid 1990s. It was a deliberate policy effort to integrate environmental considerations into the country's economic and social development. The integration process was to be achieved through a multi-sectoral approach to develop a comprehensive framework to ensure that environmental management and conservation of natural resources are an integral part of societal decision making. The NEAP also establishes the process of identifying environmental problems and issues, raising environmental awareness, building national consensus, defining policies, legislation and institutional needs and planning environmental projects.	The programme activities will interact with the various elements and components of the physical, social and economic environments in ways that could lead to negative impacts. Stakeholders in the project will therefore ensure that projects covered within the Programmes under consideration should be implemented in ways that ensure environmental integrity. Issues of environmental integrity will be addressed through project level Environmental Impact Assessments (EIAs).

4.3 NIB plans and strategies

Table 4. 2: NIB Plans and Strategies

Strategy	Relevance to the programmes
National Irrigation Board (NIB) Strategic Plan The NIB Strategic Plan aims at setting the overall direction and activities of NIB in the irrigation and drainage sub-sector to ensure effective implementation of Vision 2030 and the First Medium Term Plan (2008-2012). The First Medium Term Plan (MTP) recognizes the important role that irrigation is expected to play in improving agricultural productivity and meeting Kenya's food security needs. Through Vision 2030, the government plans to increase the area under irrigation and drainage from the current 119,200hectares to 1.2 million hectares in 2030 and expansion of irrigation acreage by 42,000 hectares per year to promote agricultural productivity. Out of this target, NIB undertakes to put an additional 32,000 ha under irrigation annually while the balance of 10,000 ha will be developed by other sector participants.	The strategic plan should guide implementation of projects under the programmes. Irrigation development and expansion are key objectives of the programmes under consideration

4.4 National Legislations

Table 4. 3: National Legislations

Legislation	Relevance to the programmes
Irrigation Act Cap 347 laws of Kenya This is an Act of Parliament to provide for the development, control and improvement of irrigation schemes, and for purposes incidental thereto and connected therewith. It establishes the National Irrigation Board (NIB) which is a body corporate having perpetual succession and a common seal. The NIB is incorporated as a non-profit generating corporate organisation 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.	National Irrigation Board will be at the apex of guiding the implementation of programme activities. All programme activities will be implemented in compliance with the provisions of this Act.
The Water Act of 2002 Cap 372 laws of Kenya The Water Act 2002 vests the rights over all water to	Availability of water of adequate quantity and quality is central to the success of programme activities. All

the state, and the power for the control of all body of water with the Minister (Cabinet Secretary) The powers is exercised through the Cabinet Secretary and the Director of water resources in consultation with the regional water resources boards. Its provisions aim at the conservation of water, apportionment, and use of water resources. The Act provides for national monitoring and information archiving system on water resources. It prohibits pollution of water	stakeholders must ensure that programme activities do not in any way interfere with water quality and quantity for competing uses. There should be constant consultations between and among key stakeholders in programme implementation on matters of water management in a bid to realise programme objectives.
Water Rules 2002 One of the outcomes of the water sector reforms has been improved regulatory framework for water resource management and use. In addition to the Water Act 2002, the main document outlining the regulations is the Water Resource Management Rules 2005. The rules set out the procedures for obtaining water use permits and the conditions placed on permit holders. Sections 54 to 69 of the Water Resources Management Rules 2005 impose certain statutory requirements on the project owners and users in regard to water use.	These rules have set out standard procedures to be followed in the utilization of water resources including abstraction, controls, modes of use and responsibilities in protection of water resources including effluent treatment standards. NIB will work closely with other stakeholders to ensure that the provisions of these regulations are complied with.
Environment Management and Coordination Act (EMCA), 1999 The main objective of this Act is the establishment of an appropriate legal and institutional framework for the management of the environment in Kenya. The Act further aims to improve the legal and administrative coordination of the diverse sectoral initiatives in the field of environment so as to enhance the national capacity for its effective management. In addition, the Act seeks to harmonize all the 77 sector specific legislations touching on the environment in a manner designed to ensure greater protection of the environment. This is in line with national objectives and sustainable development goals enunciated in the Agenda 21 of the Earth Summit held in Rio de Janeiro in 1992. The ultimate objective is to provide a framework for integrating environmental considerations into the country's overall economic and social development. In terms of environmental management, the EMCA Act, 1999, provides a comprehensive and an appropriately harmonized legal and institutional framework for the handling of all environmental issues in Kenya and covers all sectoral laws.	Environmental Management and Coordination Act provide a legal and institutional framework for the management of the environment- related matters. Environmental quality conservation aspects of projects under the programmes in consideration will be realized through the implementation of the Environmental Management & Social Monitoring Plan aimed at mitigating the potentially negative impacts and enhancing the potentially positive impacts predicted through project level EIAs.
Occupational Safety and Health Act (OSHA), 2007	Activities associated with construction such as excavating

Cap 514 Laws of Kenya The Act makes provision for the health, safety and welfare of persons employed in factories and other places of work. The provision requires that all practicable measures be taken to protect persons employed in the factory and other places of work from any injury. The provisions of the Act are also relevant to the management of hazardous and non hazardous wastes, which may arise at the project site. The Act provides that all measures should be taken to ensure safety, health and welfare of the all stakeholders in the work place.	of trenches, movement of construction vehicles, the use of equipment and the congregation of workers and staff on site increase the risk of occupational injury. Construction activities will also result in access of the area by vehicles delivering materials to the site that may result in accidents/incidents. Work at the proposed sites may involve hazards such as accidental falls into open trenches, working at heights, exposure to energized circuits, and heavy equipment. Other potential sources of occupational injuries include entry into confined spaces, including manholes, dust generation associated with operation and circulation of construction vehicles and equipment, as well as by wind dispersal of excavated material among others.
Environmental Impact Assessment and audit regulations 2003. Regulation 42 of the Environmental (Impact Assessment and Audit) Regulations 2003 requires all proposals for public policy, plans and programmes to be subjected to SEA. Section 43 (3) of the Regulation commits the government and all lead agencies to incorporate SEA principles in the development of Sectoral, national and regional policies.	The SEA process has been guided by provisions of these regulations.
The Surveys Act Cap 299 Laws of Kenya This is an Act of parliament that make provisions in relation to surveys and geographical names and the licensing of land surveyors.	Surveyors shall carry out surveying in a manner as to ensure that surveys accords in all respect with the provisions of this Act and regulations made there under and shall be responsible for correctness and completeness of every survey carried out by them or under their supervision. Boundaries and bench marks for any land or holding should be shown on the map.
Environmental Management and Co-Ordination (Water Quality) Regulations, 2006 These Regulations apply to drinking water, water used for industrial purposes, water used for agricultural purposes, water used for recreational purposes, water used for fisheries and wildlife, and water used for any other purposes. The Regulations provide for prevention of water pollution. They require every person to refrain from any act which directly or indirectly causes, or may cause immediate or subsequent water pollution. The regulations also require that no person shall throw or cause to flow into or near a water resource any liquid, solid or gaseous substance or deposit any such substance in or near it, as to cause pollution.	Soil erosion may arise due to uncontrolled excavation of trenches during rainy seasons and from inadequacies in backfilling during construction works. Improper drainage of storm water may lead to contamination of surface water bodies. Provisions of these regulations with regard to water quality will be adhered to in order to foster sustainable development principles.

The Public Health Act Cap 242 Laws of Kenya The Act contains comprehensive provisions on discharges of pollutants into watercourses among other prohibitions. The Act makes it the duty of every local authority (in the capacity of "health" authority) to take all lawful, necessary and reasonably practicable measures to safeguard and promote public health. Section 13 Part IX of the Act deals with sanitation and housing, and is of most significance for the control of polluting discharges. The Act also makes provision for protecting from pollution sources of drinking water supply. Section 129 makes it the duty of the Local authorities to prevent such pollution, to purify a pollution source and to prosecute the polluters. The Cabinet Secretary may make, and require local authorities to enforce rules for preventing polluting activities threatening such drinking water supply, and for purifying polluted water.	Health issues will be integrated into the project to ensure environmental health is appropriately addressed. All stakeholders must undertake to comply with provisions of the regulations by ensuring that the necessary plans to achieve requirements of the regulations are put in place. Measures to mitigate all forms of nuisance in compliance with Part IX Sections 115 and 118 of the Act will be put in place throughout the phases of projects under the programmes Contractors will also manage solid waste arising from programme related activities in compliance with provisions of this Act.
The Penal Code Cap 63 Chapter XVII on "Nuisances and offences against health and convenience" contained in the Penal Code strictly prohibits the release of foul air into the environment which affects the health of the persons. It states "Any person who voluntarily vitiates the atmosphere in any place so as to make it noxious to the health of persons in general dwelling or carrying on business in the neighbourhood or passing along a public way is guilty of a misdemeanor".	All stakeholders will comply with provisions of the Code prohibiting fouling of water (section 191) and fouling of air (Section 192 and construction and operation processes will be carried out in a way that fosters sustainable development principles.
Noise and Excessive Vibration Pollution (Control) Regulations, 2009. Under Part II , section 3 on 'General prohibitions', the Regulations provide that no person shall make or cause to be made any loud, unreasonable, unnecessary or unusual noise which annoys, disturbs, injures or endangers the comfort, repose, health or safety of others and the environment. In determining whether noise is loud, unreasonable, unnecessary or unusual; various factors including time of the day; proximity to residential area; whether the noise is recurrent, intermittent or constant; and the level and intensity of the noise among others may be considered. Any person who contravenes the provisions of this Regulation commits an offence.	Sources of noise during implementation of programme activities include site machines and construction vehicles. Neighbouring communities should not be affected by noise from construction sites. Contractors will ensure that noise levels at all construction sites are within regulatory limits stipulated in the First Schedule of these regulations. Where the levels are exceeded, and especially for construction workers, mitigative measures including wearing ear protection and carrying out construction activities during daytime will be put in place.
Solid Waste Regulations 2006 These Regulations apply to all categories of waste	Construction works will involve opening up of access roads to material abstraction and intake works.

including solid waste, industrial waste, hazardous waste, pesticides and toxic substances, biomedical wastes and radioactive substances. Part II of the regulations prescribes responsibility of waste generators. The regulations also provide for any person who owns or controls a facility or premises which generates waste to minimize the waste generated by adopting cleaner production principles which include among others: improvement of production process through conservation of raw materials and energy; eliminating the use of toxic raw materials within such time as may be prescribed by the Authority and reducing toxic emissions and wastes, monitoring the product cycle from beginning to end.	Excavation and trenching works will generate spoils that will need to be disposed of properly. Provisions of these regulations with regard to waste management and cleaner production principles will be observed by all stakeholders.

4.5 Multilateral Environmental Agreements

Table 4. 4: Multilateral Environmental Agreements

Agreement	Relevance to the Programmes
International Convention on Biological Diversity (CBD) of 1992 This is a multilateral treaty with three main goals which include conservation of biological diversity (or biodiversity); sustainable use of its components; and fair and equitable sharing of benefits arising from genetic resources. Its objective is to develop national strategies for the conservation and sustainable use of biological diversity. The agreement links traditional conservation efforts to the economic goal of using biological resources sustainably. It also covers the rapidly expanding field of biotechnology through its Cartagena Protocol Biosafety, addressing technology development and transfer, benefit-sharing and Biosafety issues. The convention also offers decision-makers guidance based on the precautionary principle that where there is a threat of significant reduction or loss of biological diversity, lack of full scientific certainty should not be used as a reason for postponing measures to avoid or minimize such a threat.	EIP and NEP are in line with the CBD and NBSAP, including the Aichi target with regards to promoting local communities appreciating and valuing biodiversity so as to conserve and use it sustainably.
Ramsar Convention of 1971 The Ramsar Convention (formally, the Convention on Wetlands of International Importance, especially as Waterfowl Habitat) is an international treaty for the conservation and sustainable utilization of wetlands	There are a number of wetlands within the programme area that support various ecological and socio-cultural functions. These wetlands are also home to wildlife of international importance and should therefore be protected throughout implementation of programme

recognizing the fundamental ecological functions of wetlands and their economic, cultural, scientific, and recreational value. The Ramsar List of Wetlands of International Importance now includes 2208 Sites (known as Ramsar Sites) covering over 210,734,269.41 ha (520,735,720.3 acres). The Ramsar definition of wetlands is fairly wide, including "areas of marine water the depth of which at low tide does not exceed six meters" as well as fish ponds, rice paddies and salt pans	activities. Tana Delta for example provides a habitat for 320 plant taxa- Fifty-eight of these are tree species, two of which are critically endangered. The delta hosts seven plants on the IUCN Red list. They include Cynometra lukei which is classified as endangered and Oxystigma msoo, Angylocalyx braunii, Dalbergia vaciniifolia, Chytranthus obliquinervis, Diospyros greenwayi and Pavetta linearifolia which are categorized as vulnerable.
Agreement of the Conservation of Eurasian Migratory Water Birds (2001) The Agreement on the Conservation of African-Eurasian Migratory Waterbirds or African-Eurasian Waterbird Agreement (AEWA) is an independent international treaty developed under the auspices of the United Nations Environment Programme's Convention on Migratory Species. It was founded to coordinate efforts to conserve bird species migrating between European and African nations, and its current scope stretches from the Arctic to South Africa, encompassing the Canadian archipelago and the Middle East as well as Europe and Africa. The agreement focuses on bird species that depend on wetlands for at least part of their lifecycle and cross international borders in their migration patterns. It currently covers 255 species.	There are a number of wetlands within the project area that support migratory birds and these need to be protected. Globally threatened birds recorded in Tana Delta include the Lappet-faced Vulture (Torgos tracheliotos), Southern Banded Snake Eagle (Circaetus fasciolatus), Malindi Pipit (Anthus melindae) and the Basra Reed Warbler (Acrocephalus griseldis).
African Convention on the Conservation of Nature and Natural Resources (1968) The objectives of this Convention are to enhance environmental protection; to foster the conservation and sustainable use of natural resources; and to harmonize and coordinate policies in these fields with a view to achieving ecologically rational, economically sound and socially acceptable development policies and programmes. The convention provides for the right of all peoples to a satisfactory environment favourable to their development; the duty of States, individually and collectively to ensure the enjoyment of the right to Development; and the duty of States to ensure that developmental and environmental needs are met in a sustainable, fair and equitable manner.	The programme area has environmentally sensitive ecosystems that need to be conserved and protected for posterity. The Arabuko-Sokoke Forest for example protects many endemic and near endemic species. The Clark's weaver is completely endemic to the forest, while the emonymous Sokoke scops owl, Sokoke pipit and the Amani sunbird and spotted ground thrush are found only here and in a forest fragment in Tanzania. The park adjoins Mida Creek, a mangrove forest that is an important shorebird wintering ground, protecting species such as the Terek sandpiper and the crab plover.
The Convention on International Trade in Endangered Species of Wildlife Fauna and Flora (CITES) 1973 This is a multilateral treaty to protect endangered plants	A number of national parks and game reserves are located within programme area. Globally threatened birds found in Tana Delta include the Lappet-faced Vulture (Torgos tracheliotos), Southern Banded Snake

and animals. Its aim is to ensure that international trade in specimens of wild animals and plants does not threaten the survival of the species in the wild, and it accords varying degrees of protection to more than 35,000 species of animals and plants. Roughly 5,000 species of animals and 29,000 species of plants are protected by CITES against over-exploitation through international trade. Each protected species or population is included in one of three lists, called Appendices.	Eagle (Circaetus fasciolatus), Malindi Pipit (Anthus melindae) and the Basra Reed Warbler (Acrocephalus griseldis). The estuaries, mangroves and shorelines provide a habitat for a wide range of fish species. Three shark species listed under the CITES Appendix 1 have been recorded in the Tana Delta area.
The United Nations Framework Convention on Climate Change (UNFCCC or FCCC) This is an international environmental treaty produced at the United Nations Conference on Environment and Development (UNCED), informally known as the Rio Earth Summit. The objective of the treaty is to stabilize greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. The treaty itself sets no mandatory limits on greenhouse gas emissions for individual countries and contains no enforcement mechanisms. In that sense, the treaty is considered legally non-binding. Instead, the treaty provides for updates (called "protocols") that would set mandatory emission limits. The principal update is the Kyoto Protocol, which has become much better known than the UNFCCC itself.	EIP and NEP will endeavor to be in line with this convention and ensure that atmospheric pollution through greenhouse gases are minimised as is practically possible.
The United Nations Convention to Combat Desertification (UNCCD) This is a Convention to combat desertification and mitigate the effects of drought through national action programs that incorporate long-term strategies supported by international cooperation and partnership arrangements. The Convention is based on the principles of participation, partnership and decentralization—the backbone of Good Governance and Sustainable Development. To help publicise the Convention, 2006 was declared "International Year of Deserts and Desertification" The Convention established a Committee on Science and Technology (CST) under Article 24 of the Convention as a subsidiary body of the COP. The committee identifies priorities for research, and recommends ways of strengthening cooperation among researchers.	Agricultural practices that are likely to result in land degradation and soil erosion should be avoided throughout programme implementation period. Soil conservation measures should be put in place throughout programme implementation period.

CHAPTER 5

5.0 OVERVIEW OF PUBLIC/STAKEHOLDER ENGAGEMENT ACTIVITIES UNDERTAKEN

5.1 Informing the potentially affected stakeholders about the PPP

Informing and consulting the public are integral tasks within any environmental assessment process in Kenya and form part of best practice. Accordingly, the TOR required the SEA consultant to organise and implement a public consultation programme in undertaking the SEA process. Informing the local people, leaders and key stakeholders about the programmes was carried out through consultative meetings, key informant interviews, questionnaire administration, email communication and telephone calls. During the consultation process, the stakeholders were taken through the programmes including their objectives, technologies of implementation and possible impacts associated with various programme activities. Stakeholders were then given time to ask relevant questions regarding the programmes to enable the consultants clarify on any issues that they may not have understood properly. Stakeholders were consulted during screening, scoping and SEA study.

5.2 Determination of who should be involved in the SEA

The SEA report benefited from extensive community consultations with a wide cross section of stakeholders. Stakeholder analysis was used to identify stakeholders that should be involved in the SEA process. The basis of inclusion of these stakeholders was their relevance informed by their activities and participation in irrigation and water resource use within Tana and Athi River basins. Their importance and significance in irrigation and water related activities within the basin were also considered. The consultations were carried out at two levels. The first was the institutional stakeholders and the second was the community stakeholders. The institutional stakeholders were drawn from line government ministries and departments, as well as the related projects. Community stakeholders on the other hand were community representatives drawn from various structures that deal with irrigation such as Water Resources User Associations, (WRUAs), Cooperative societies, Community Irrigation Projects, Women groups, groups for persons with disabilities and youth groups

5.3 Methods used to inform relevant stakeholders about the PPP.

The following is a summary of the methods used to consult various stakeholders during the SEA study.

5.3.1 Focused Group Discussions (FGD)

Focus group discussions were held with various interest groups within the study area in order to share ideas about the programmes under study. The discussions were arranged in consultation with leadership of the various interest groups consulted through this method. Those consulted through this method include officials of key government ministries among them Ministry of Water and Irrigation, Ministry of Agriculture Livestock and Fisheries; officials of farmer organizations (Community irrigation project committees/Water

Resources Users Association and Farmer cooperative societies). During the discussions, stakeholders were taken through the objectives of the programmes and impacts anticipated as a result of implementation of programme components. Records of their inputs were taken.

5.3.2 Key informant interviews

One-on-one interviews with key stakeholders within the programme area were undertaken to assist in analysis of existing and anticipated impacts of programme activities to the community and institutions within the project area. These interviews were conducted to augment and confirm data and information obtained using other tools and methodologies. The interviews were focused on getting information from key stakeholders within the programme area and focused on heads of departments of government agencies, parastatals, Irrigation funders, Regional Development Authorities, Water Service Boards and Water Resources Management Authority (WRMA).

Plate 6: SEA team with a key informant at a dam site in Nyeri

5.3.3 Questionnaire Administration

Guiding questions were prepared and administered to various stakeholders identified during the study. Those interviewed provided critical insights with regard to socio-economic activities within the project area and how programme activities are likely to impact on local populations. Those consulted through this method include cabinet committee members in charge of agriculture, water and irrigation; County Directors in charge of agriculture, water and irrigation; Technical Managers of Water Service Boards; Technical

Managers of Water and Sewerage/Sanitation Companies and representatives of irrigation funders within the basin including TARDA, County Governments and CDF committees.

5.3.4 Community consultative meetings

The consultative meetings served two purposes. First they offered an opportunity for stakeholder sensitisation on the programmes. Secondly, they presented an opportunity for the SEA study team to gather data and information on issues relevant to the SEA study. To better address the latter objective, participants were first taken through the key highlights of the issues to be explored under the SEA study. The presentation was followed by a plenary session where clarifications and elaborations were sought. Participants were then divided into groups based on the sector one represented. This strategy worked in ensuring people was responding to issues based on their daily experiences.

In the breakout groups participants were issued with a list of questions to guide their discussions. The questions were aimed at generating additional information from the participants which could compliment what was already available in documents. More time was allowed for these discussions. In general institutional stakeholders highlighted the need to highlight and document ways in which the project fits in within the broader legislative and policy framework in the county. They also observed that issues on climate change will need to be explored and documented. Climate change is directly linked to programme activities. Participants further highlighted some of the key environmental and social concerns that need to be incorporated into the SEA report. Similar suggestions came from community stakeholders. The table below gives a summary of group meetings and discussions held to inform and get responses from stakeholders about the programmes. Summary of individual meetings is contained in appendix 1 and 5 of this report.

Table 5. 1: Summary of meetings held to inform stakeholders about the programmes

No.	Date and Time	Venue	Activity
1	9th December, 2014	NIB Offices, Mwea	Meeting with NIB staff at Mwea Irrigation Scheme
2	9thDecember, 2014	Miad Centre	Meeting with NIB staff at MIAD centre
3	10th December, 2014	NIB offices Nyeri	Meeting with NIB Staff in Nyeri office
4	11th December ,2014	Masinga Dam Resort	Meeting with TARDA representatives
5	23rd January 2015	Rwatha Karethani Irrigation office	Meeting with irrigation project committee and farmer (block) representatives
6	24th January.2015	Mitunguu Irrigation Scheme office	Meeting with irrigation project committee and farmer (block) representatives
7	27th January.2015	Gura Ugaciku Irrigation Scheme office	Meeting with irrigation project committee and farmer (block) representatives
8	29 January.2015	Kalundu Sand and Check dams office	Meeting with irrigation project committee and farmer (block) representatives
9	20 April 2015	Bwathonaro River WRUA	Meeting with WRUA officials and farmer (block) representatives
10	21 April 2015	Mikinduri – Marega Irrigation	Meeting with irrigation project committee and

		Project office	farmer (block) representatives
11	21 April 2015	Muringa Banana Irrigation Project office	Meeting with irrigation project committee and farmer (block) representatives
12	21st April/2015	Double Heart Resort, Malindi	Stakeholders from Kilifi County led by the County Commissioner
13	22 April 2015	Turima Tweru Irrigation Project office	Meeting with irrigation project committee and farmer (block) representatives
14	22 April 2015	Kamatungu Kithingiri Irrigation Project office	Meeting with irrigation project committee and farmer (block) representatives
15	24th January 2015	Kiaga Multi Purpose Cooperative Society	Meeting with the society committee
16	24 April 2015	Wikithuki Irrigation Project office	Meeting with irrigation project committee and farmer (block) representatives
17	25th January 2015	Mwiria Multipurpose Cooperative society	Meeting with society committee
18	25 April 2015	Gikondi Irrigation Project office	Meeting with irrigation project committee and farmer (block) representatives
19	27 April 2015	Sagana Irrigation Scheme office	Meeting with irrigation project committee and farmer (block) representatives
20	28 April 2015	Rupingazi Weru Irrigation Project office	Meeting with irrigation project committee and farmer (block) representatives
21	29th April 2014	Double Heart Resort, Malindi	Stakeholders from Kilifi County led by the County Commissioner
22	05-05-2015	TARDA office, Nairobi	Meeting with Technical Committee members

5.3.5 Stakeholder Consultative Meetings

Consultative meetings were organised by the SEA team after conclusion of field work for Scoping Study. The meetings were held at County and community levels. The meetings targeted stakeholders consulted earlier in the study and the objectives of the meetings included presentation of findings of the Scoping Study to key stakeholders consulted and deliberation on the findings with a view to filling any gap identified. The table below gives a summary of stakeholder consultation plan pursued during Scoping Process

Table 5. 2: Summary of stakeholder consultation plan during scoping process

Method Used	Stakeholders Consulted
Focused Group Discussions (FGD)	• Officials of key government ministries including Ministry of Water and Irrigation, Ministry of Agriculture Livestock and Fisheries; • Officials of farmer organizations among them Community irrigation project committees, Farmer cooperative societies and Water Resources Users Association (WRUAs).
Key informant interviews	• Heads of departments of government ministries, agencies,

	parastatals and irrigation funders; • Regional development authorities; • Water Service Boards; and • Water Resources Management Authority (WRMA).
Questionnaire Administration	• Cabinet committee members in charge of agriculture, water and irrigation; • County Directors in charge of agriculture, water and irrigation; • Technical Managers of Water Service Boards; • Technical Managers of Water and Sewerage/Sanitation Companies; and • Representatives of Irrigation Funders within the basin
Community Consultative meetings	• Members of water resources users associations (WRUAs); • Members of cooperative societies; and • Members of community Irrigation Project Committees.
Stakeholder Consultative Meetings	• Heads of departments of government agencies, parastatals Irrigation funders • Regional development authorities, • Water Service Boards • Water Resources Management Authority (WRMA).
Direct Interviews	• Farmers within the basin • Members of the public

5.4 Organisation and communication of potential impacts and concerns to stakeholders

Preliminary meetings were organised by various county leadership including County Commissioners' Offices, County Irrigation Offices, County Water Offices, and County Agriculture offices with the aim of identifying critical stakeholders that could be relied on to provide relevant data and information for the study. These meetings were meant to analyse the various stakeholders that are of relevance in the proposed study. Stakeholder relevance was looked at in terms of their roles in socio-economic development within Tana and Athi River Basins and were categorised based on their functions within the basin. The clusters into which stakeholders were organised for the purposes of this study include government ministries, government agencies, county government officials, Non- Governmental organisations and community/farmer organizations. Other clusters include private developers, Water resources users, Regional Development Authorities, Water Service Companies/Providers, Water Service Boards and individual members. Potential impacts were then communicated to them through direct interviews, stakeholder meetings and questionnaire administration.

5.5 Values held by stakeholders about the quality of the environment that might be affected by the PPP

The local stakeholders value the environment as source of their livelihood, provider of ecosystem services and source of basic needs. They see a healthy environment in terms of the following:

- Provisioning services which are the most recognizable as benefits to people. These include food (such as fish and crops), fibre and fuel, but also genetic material;
- Regulating services which ensure that ecosystems keep on functioning through changes and include climate regulation; water regulation; water purification and waste treatment; erosion regulation; natural hazard regulation; and pollination.
- Provision of cultural services which are generally non-tangible and include spiritual and inspirational, recreational, aesthetic, and educational needs.
- Supporting services which are basically functions that provided over a long-term time and include soil formation and nutrient cycling.

The stakeholders contacted feel that they would lose various benefits associated with their ecosystem if the proposed programmes are not implemented in a sustainable way. Among the environmental benefits that they fear losing include:

- Clean and freshwater from local rivers both for livestock and domestic use due to competition from multiple users and potential pollution;
- Loss of sources of wood fuel and domestic energy;
- Loss of ecosystem functions of environmental resources including water recharge; water purification, nutrient cycling, soil formation and flood regulation;
- Loss of grazing fields for pastoralists; and
- Loss of source of food e.g. fish from the local rivers in instances where these rivers are polluted from agrochemicals or depleted due to intensified use.

5.6 Evaluation of stakeholder concerns and determination of how / whether to pursue them further

The concept of significance is at the core of impact assessment, impact evaluation and decision-making. The forms of recognition used in the determination of impact significance in this study included institutional, public and technical recognitions. In institutional recognition, importance of stakeholder concerns/environmental impacts were determined based on how they relate to existing laws and regulations, plans or policy statements of government agencies and private groups including farmer organizations. Under Public recognition, perceptions by stakeholders on the various resources were determined based on their belief systems and benefits they associate with the resource in question and what they are likely to lose should the resource be interfered with. In technical recognition, the importance of environmental resources or attributes was based on scientific or technical knowledge or judgment of the critical resource characteristics.

A number of factors were considered in determining how and whether to pursue stakeholder concerns further. These factors were related to impact characteristics of stakeholder concerns and they include:

- The probability, duration, frequency and reversibility of the effects of impacts of proposed actions;
- The transboundary nature of the effects;

- The risks the impacts of concern pose to human health and the environment;
- The magnitude and spatial extent of the effects (i.e., geographical area and size of the population likely to be affected);
- The impacts that are related to critical stakeholders who were not interviewed during scoping process will be studied in details during SEA study.

CHAPTER 6

6.0 PREDICTION AND EVALUATION OF IMPACTS, INCLUDING CUMULATIVE EFFECTS

6.1 Possible effects of the proposed programmes on the environment

6.1.1 Socio-economic impacts

Socio-economic impacts associated with programme activities include increase in crop production area, increase in fisheries and tourism opportunities and increase in food and income. Employment opportunities will also be available to local people especially in water related sectors.

Changing land use patterns occasioned by construction of large dam and putting up of large area hitherto grazing land into irrigated agriculture may have other impacts on social and economic structures of the project area. Small plots, communal land use rights, and conflicting traditional and legal land rights all create difficulties when land is converted for irrigated agriculture. Land tenure/ownership patterns are almost certain to be disrupted by major water infrastructure works (dams) as well as new irrigation project (Galana/Kulalu Food Security Project).

Dams will affect the social, cultural and economic structure of the region considerably, especially forcing people, whose settlement areas and lands fall within the dam area to migrate affecting them socially and psychologically.

6.1.2 Public health impacts

Public health impacts related to programme activities include increase in incidents of water-borne or water-related diseases which are commonly associated with basin irrigation. The diseases most directly linked with irrigation are malaria, bilharzia (schistosomiasis) and river blindness (onchocerciasis), whose vectors proliferate in the irrigation waters.

6.1.3 Ecological impacts

Individual projects under EIP and NEP like construction of Thiba and Galana-Kulalu dams will check on floods downstream. As a result of damming, decreasing amounts of fresh water are available to maintain ecological values and related ecosystem services e.g stream migration of aquatic animals during breeding.

Hydrological alterations can affect genes to ecosystems through genetic isolation as a result of habitat fragmentation which could lead to changes in ecosystem-level processes such as nutrient cycling and primary production. This may impact negatively on biodiversity. Increased discharges from farmlands may negatively affect water quality. Fishery within local rivers (for instance River Sagana) usually decline due to changes in river flow, deterioration of water quality, water temperature changes, loss of spawning grounds and barriers to fish migration.

Reduction or elimination of flooding has the potential for impoverishing flood recession cropping, groundwater recharge, natural vegetation, wildlife and livestock population in the flood plains (in the middle and lower zones) which are adapted to the natural flood cycles.

6.1.4 Changes in pests and diseases

Intensification of agriculture is likely to result in intensification of problems from pests and diseases. At present crop pests and diseases cause major economic losses within the two river basins. Irrigation and drainage will remove primary constraints to crop productivity; after plant nutrition is dealt with (by fertilisers), biotic constraints (weeds, insects and diseases) are likely to prove the most significant limiting factors, especially for horticultural crops. Improved wet season drainage is likely to create more favourable conditions for cutworm larval survival (reductions in extent and duration of soil flooding, which can drive cutworms to the surface where they may be killed by exposure or predated). In addition, moist conditions created by dry-season irrigation will also favour these pests.

6.1.5 Loss of vegetation and wildlife habitats

Construction activities will involve some vegetation clearance within project alignment areas especially at the intake works and access roads. Expansion of agricultural lands will also lead to vegetation clearance greatly interfering with wildlife habitats within the affected areas. Other groups of fauna could also be affected by the works. Construction works will reduce available feeding and breeding habitats for local fauna and will affect access to vegetative resources within the project alignment area. This may ultimately lead to human-wildlife conflicts.

6.1.6 Interference with ecosystem diversity within the programme area

Water within local Rivers and other seasonal rivers and streams flowing within Tana and Athi river basins are habitat for various types of aquatic organisms, which are important scientifically, ecologically and economically. These organisms also provide food for higher level of the food chain, especially birds. The programme may affect water quality by augmenting normal dry season and wet season flows with drainage (return) flows from fields (especially during rainy season). These return flows will carry chemicals added to the fields and not immobilised, biodegraded or taken up by plants, including pesticides, fertilisers and salts. The nitrogen and phosphorus in fertilisers will act as an accelerant to already high growth potential of weeds and other aquatic organisms, risking algal blooms and subsequent deoxygenation in stagnant or shallow waters. The table below gives a summary of the potential programme impacts on the biophysical environment.

Table 6. 1: Summary of Potential impacts on biophysical environment, assessment methodology and governing standards

Issues	Potential Impacts	Proposed Assessment Methodology	Relevant standards/ guidelines and policies
Water Resources	• Overuse of the available and rather limited water supply,	• Hydrological survey of water resources within the basin • Field observations and GIS-	• The Water Act 2002 • The Public Health Act • EMCA, 1999

	and possible depletion of the same • Contamination of surface and groundwater sources by wastewater	based mapping from existing paper maps • Review of existing water quality monitoring results from the local rivers to ascertain pollution levels.	• EMCA (Water quality regulations) 2006 • The National Water Master Plan, 2030
Soils	• Disturbance of soil through excavation and construction of irrigation infrastructure • Contamination of soil through disposal of wastes and/ or accidental spillage • Soil degradation resulting from vegetation clearance • Soil erosion as a result of intensification of agricultural activities	• Field observation to identify soil types and structures and establish baseline soil conditions • GIS mapping from existing soil and vegetation maps	• The Public Health Act, Cap. 242 ; Section 118 (c) • EMCA, 1999
Ecosystems Terrestrial environment (Habitats, Flora and Fauna)	• Reduced vegetation cover • Disturbance of wildlife	• Review of existing literature on habitats, and biodiversity within the basin • Field observation and assessment of habitats (flora and fauna) • Mapping of key information such as wildlife reserves, migration corridors and nesting grounds	• The Environmental Management and Co-ordination (Conservation of Biological Diversity and Resources, Access to Genetic Resources and Benefit-Sharing) Regulations, 2006
Aquatic Environment (Habitats, Flora and Fauna)	• Pollution of habitats through waste disposal and sedimentation • Loss of life through habitat destruction • Disturbance of aquatic animals, breeding and nesting grounds	• Review of existing literature on habitats, and biodiversity • Field observation and assessment of habitats (flora and fauna) • Mapping of key information such as nesting grounds	• The Environmental Management and Co-ordination (Water Quality) Regulations, 2006

6.2 Possible effects on people due to environmental changes

6.2.1 Human wildlife conflicts in areas bordering National Parks

During the operation stage, crops on the farms could be affected adversely through encroachment by wildlife. This may lead to perpetual human-wildlife conflicts. Restriction of wildlife movement within the

project area will also result in more human-wildlife conflict in the surrounding areas or even in the irrigated land. In addition, increased human settlement within the project area as a result of project activities may lead to increased human attacks by wildlife and vice-versa.

6.2.2 Increase in public health threats due to water pollution from agricultural activities

Irrigation projects have contributed to pollution of water bodies through release of agrochemicals. Pollution of water resources within the project area will impose a high cost on the economy through detrimental health impacts and increased treatment costs for drinking water. Water pollution arising from urban life within the Athi River Basin is not only evident in Nairobi, but also in Athi River Town (slaughter house and tannery) and Mombasa (fishing industry, chemical industries, oil industry and agro-processing industries)

6.2.3 Strain in water availability due to many irrigation projects and competing uses

Currently, there are irrigation projects at various levels of implementation within Tana and Athi river basins. More people are also taking up irrigation farming due to climate change issues as they can no longer rely on rainfed agriculture. This situation is likely to worsen with implementation of proposed programmes. The challenges of water scarcity have for example led to water rationing for irrigation water users within Athi and Tana River basins.

6.2.4 Loss of economically significant flora and fauna and environmentally significant areas

An upsurge in catchment degradation within the programme area through cutting down of trees may lead to loss of economically significant fauna and flora and degradation of environmentally important areas. This may further interfere with ecosystem functions within the programme area with attendant environmental consequences.

6.2.5 Loss of livelihoods

Expansion of agricultural activities will ultimately result in the displacement of existing land uses. Some of the areas earmarked for agricultural expansion and for development of infrastructure to support agricultural uses are currently in use by the local people for other activities and economic functions. These are likely to be forgone once the programmes are implemented as proposed resulting in loss of livelihoods.

6.2.6 Conflicts between pastoralists and farmers

Conflicts between pastoralists and farmers may intensify especially in lower Tana area and sections of Athi River basin. This will be excercabated by conversion of hitherto grazing fields into agricultural lands. Pastoralists may set their livestock in agricultural farms leading to conflicts with farmers. The table below gives a summary of the potential socio-economic impacts associated with programme activities.

CHAPTER 7

7.0 ALTERNATIVE PPP OPTIONS CONSIDERED AND COMPARED AGAINST ENVIRONMENTAL INDICATORS

7.1 Environmental indicators

The National Economic Programme (Galana Kulalu Food Security Project) and the Expanded Irrigation programme spearheaded by the National Irrigation Board (NIB) both have the objective of attainment of national food security and elimination hunger amongst Kenyans through irrigated agricultural production. Most of the projects under these programmes fall within the Tana and Athi River Basins where other governmental and non governmental agencies are also involved in implementation of various projects.

The main goal of the programmes under study is to contribute to reduction of rural poverty not only within Tana and Athi river basins but also throughout the country through increased sustainable food production and incomes for rural households and sustainable management of natural resources for provision of environmental services. The environmental and social indicators for desired outcomes of the proposed programmes include:

- Quality status (biology and chemistry) of rivers, within the programme area.
- Quality and quantity of groundwater within the programme area
- Water use (by sector, including leakage), availability and proportions recycled
- Water availability for competing uses and water-dependent habitats, especially designated wetlands Degraded land/ land identified as derelict within the programme area (number of hectares)
- Amount of waste generated as a result of proposed programmes
- Percent of waste recycled or reused
- Reported levels of damage to designated sites/species
- Conditions of nationally important wildlife sites, Sites of Special Scientific Interest (SSSI) etc.
- Amount of development in the floodplain
- Flood risk
- Investment in agricultural production
- Employment opportunities created through agricultural enterprises
- Increase of income levels among the local people

To meet these targets, a number of alternatives were considered for programme implementation and they include the following:-

7.2 Option 1: Maintenance of Status Quo (No-Programme Option)

The current agricultural practices within Tana and Athi River basins are characterised by farmers relying partly on rain fed and irrigated agriculture. This farming model presupposes that farmers make agricultural choices based on their individual capacities as far as obtaining agricultural inputs and use of technology is

concerned. This farming model has over time been associated with various effects that directly and indirectly impact on natural and socio-economic environmental elements within the programme area.

To begin with, are a number of wetlands within the programme area which are of great ecological and socio-economic significance. Wetlands within the Tana basin include the Tana River, Tana Delta and Seven Forks hydropower dams while within Athi River basin, wetlands include Athi River, Ramisi River, Nairobi River and Lake Amboseli among others. These wetlands provide critical habitats for a wide range of flora and fauna. Their biodiversity includes a large number of aquatic plants, fish, herbivores and avifauna of resident and migratory birds; important sources of water for human consumption, agriculture and watering of livestock. They recharge wells and springs that are often the only source of water to some rural communities, for livestock watering and for wildlife support systems. The recharging of aquifers raises the water table making groundwater easily accessible. This has been the case along the Tana River corridor and in the Chyulu hills; catchment area for Mzima springs and the Nol-Turesh water supply system. Wetlands provide economic benefits through fisheries and generation of products such as fuelwood, building material, medicine, honey and various types of natural foods; and are important grazing areas. They are the only sources of water and pasture/fodder for the pastoral communities during drought in the ASALs over and above serving a wide variety of ecosystem functions including flood control, water purification, shoreline stabilization and sequestration of carbon dioxide. Socio-economic activities within the programme area have significantly interfered with these resources and this has led to various ecological and socio-economic impacts.

The programme area is also home to a number of national parks and game reserves that act as habitats of wildlife. Some of the national parks and game reserves within the programme area include Aberdare National Park, Amboseli National Park, Arabuko Sokoke National Park, Chyulu Hills National Park, Kisite-Mpunguti Marine National Park, Malindi Marine National Park, Meru National Park and Mombasa Marine National Park and Reserve. Others include Mount Kenya National Park, Nairobi National Park, Tsavo East National Park, Watamu Marine National Park, Arawale National Reserve, Boni National Reserve and Dodori National Reserve. The parks are used as wildlife conservation areas and wildlife in the parks include the African elephant, Cape buffalo, impala, lion, cheetah, spotted hyena, giraffe, zebra and wildebeest among other wildlife. There is also a host of Kenyan birds, both large and small within these habitats. The Arabuko-Sokoke forest for example protects many endemic and near endemic species. The Clark's weaver is completely endemic to the forest, while the Sokoke scops owl, Sokoke pipit and the Amani sunbird and spotted ground thrush are found only here and in a forest fragment in Tanzania. Arabuko-Sokoke Park adjoins Mida Creek, a mangrove forest that is an important shorebird wintering ground, protecting species such as the Terek sandpiper and the crab plover. Euphorbia tanaensis is a critically endangered plant found in the Witu Forest Reserve where there are only 20 mature plants according to the IUCN Red List of Threatened Species (IUCN 2009). With this rich ecological diversity, it is significant that activities planned for implementation within the programme area are well thought out and are those that promote sustainable development.

It is important to note however, that socio-economic activities as currently practiced within the Tana and Athi River basins have led to various pressures on resources. The pressures in Tana River basin include inappropriate land use; overutilization of water; conversion of land to agriculture; overstocking of livestock; conversion of land to settlements; loss of catchment forests; increased demand for resources; reduced water levels; and land subdivision and fragmentation. In Athi basin, pressures include over-exploitation of surface and ground water resources; wetlands resources degradation; unregulated diversions of river channels; catchment degradation due to overgrazing and sand harvesting; land use changes for settlement and agriculture; and climate change and variability. These pressures have led to pollution of local water bodies; soil erosion/ siltation; overgrazing; reduced water volume; loss of critical habitats and species; reduced hydrological capacity; acute water scarcity due to high water demand; limited ground water recharge; changing river regime and pollution of water resources from industrial effluents; and agricultural and domestic waste. This has impacted in a significant way on the wetlands and wildlife habitats within the programme area.

More importantly, there are a number of existing and planned projects within the programme area that are likely to compete for resources and especially water use with the proposed programmes activities. Major projects include Lamu Port-Southern Sudan-Ethiopia Transport (LAPSSET) corridor project; construction of High Grand Falls; expansion of Mwea Irrigation Scheme; construction of Galana/ Kulalu Food Security Project (GKFSP) and Construction of Thiba Dam. Others include construction of Munyu Multipurpose Dam; Tana Delta Irrigation Project; Northern Collector Tunnel Project; construction of Thwake Multi-Purpose Dam; and Mt Kenya Ecosystem Management Plan among others. There are also small scale irrigation projects targeting areas of between 150-200 acres. They include among others Kiaga Irrigation Scheme; Greater Kibwezi Irrigation scheme; Karia Irrigation Scheme; Kaithewa Irrigation Scheme; Lower Athi Irrigation Scheme; and Mwiria Irrigation Scheme. The development of the projects will open up the region for investment create considerable demand for goods and services in the area and strongly impact on economic activities which may aggrevate competition for resources.

The “No Programme Option” will therefore lead to a situation where the existing problems and pressures will continue to obtain within the programme area and the option will therefore not provide any significant advantages with regard to resource use and management. Looked at from the backdrop of pressures within the basins, planned developments and environmental benefits of the various resources within the two basins, it can be concluded that the “No Project Option” may further aggrevate resource use conflicts that are already experienced within the programme area.

7.3 Option 2: Implementation of NIB Programs as proposed

The projects under Expanded Irrigation Programme (EIP) are categorized on the basis of size and nature of work to be involved in their implementation. They are categorised as either large scale projects implemented by NIB and rehabilitation of smallholder projects implemented in collaboration with Irrigation Department of the Ministry of Water and Irrigation (MWI). The classification of the programme initiatives into sub programmes clearly brings out the targeted categories and components under focus and includes progress initiatives, start-up initiatives, affirmative initiatives, design initiatives and capacity initiatives.

Progress initiatives focuses on the completion of ongoing projects countrywide and 48 600 acres of land will be brought under irrigation to benefit 610,000 households. The start -up initiatives targets new irrigation projects and is to bring 18700 acres under irrigation in 2011/12, 700 acres by 2912/13 and benefit 319,000 households. Affirmative initiatives are efforts geared towards developing irrigation projects in the northern part of Kenya and targets putting 5575 acres under irrigation for the benefit of 334,000 households while design initiatives focuses on speeding up the completion of irrigation designs in strategic areas of the basin and aims to put 85,000 acres of land under irrigation to benefit 375,000 households. Capacity initiatives aim to enhance capacity of NIB's human resource, technical competence and financial management capacity to ensure effective management of project implementation.

Under the National Economic Programme (NEP) is the Galana/Kulalu Food Security Project (GKFSP) where the government targets to put one million acres under irrigation and other enterprises by year 2017. The enterprises proposed for implementation under GKFSP include maize enterprises (525,253 acres under irrigated maize production); sugarcane enterprises (311,731 acres); fruit / orchard enterprises (134,143 acres); vegetable enterprises (52,529 acres); dairy production enterprises (109,116 acres); game and beef ranching enterprises (295,752 acres); goat and sheep enterprises (integrated in the area zoned ranching adjacent to the Tsavo East National Park); poultry and fisheries enterprises (integrated in areas zoned for dairy and horticulture) and the proposed new town (117,805 acres). Others include tourism development enterprises and human settlement zone.

Despite the fact that the programmes activities are well planned, it has been realised from the scoping process that the basin has various challenges that need to be adequately addressed before implementation of any development project. These challenges are developmental, environmental and resource management based and are prevalent within the project area. They include pollution of local Rivers by wastes from upcoming settlements and urban/town centres, lack of reliable sources of water in ASAL areas, human wildlife conflicts in areas bordering National Parks, encroachment of wetlands, pollution of water due to release of agrochemicals and strain in water availability due to many irrigation projects and competing uses. Other pressures include lack of storage facilities in most irrigation projects, poor land use practices and catchment degradation, illegal water abstraction by irrigation water users, conflicts between pastoralists and farmers in lower Tana and climate change impacts. The proposed programmes may further aggrevate these challenges if not implemented in a sustainable way. Implementations of the programmes are however premised on proper planning; adequate consultation and capacity building of the beneficiary communities in attempt to promote sustainable development. This option however offer more benefits compared to the "No Programme "option.

7.4 Option 3: Conservation- Oriented Alternative

This option will explore opportunities for strengthening the proposed programmes in order to enhance environmental sustainability and optimise resource use. Under this alternative, technologies for water harvesting, farming methods to be used, linkage of farmers to the market, agricultural mechanization, existing farm sizes and provision of input and credit to farmers have been analysed. Irrigation and technologies for water harvesting as they relate to adoption of innovative concepts have been analysed.

Irrigation intensification has been considered in terms of application of best practices towards utilization of developed irrigation space and scarce water resources to realize better crop production. The applicable modern irrigation technologies have been looked at from the point of view of improvement of efficiency in water use.

Farming methods have been looked at from the backdrop of the effects of adverse climate change, erratic rainfall patterns and need to enhance agricultural productivity while provision of inputs and credits to farmers have been looked at from the point of view of economic conditions of the local farmers and the extent to which they require support to engage in profitable agricultural practices. Mechanization of agricultural production was considered as a platform upon which efficiency in crop husbandry can be improved. The linkage of agricultural mechanization to farm sizes has been critically looked at taking due consideration of decreasing farm sizes due to subdivisions.

Some of the salient features of this option is providing alternative water points to persons who may be adversely affected by the operation of the programmes as proposed; mapping all water resources and wetlands within the catchment and protecting them ; putting together some small scale irrigation schemes to form medium or large scale schemes with a provision of common intake to assist in regulating the water abstractors; ensuring that any expansion or development of an irrigation project should be storage based and building the capacity of the water users so that they are equipped with basic monitoring skills. Community dialogue will be spearheaded through establishment of more Water Resources Users Associations (WRUAs) within Tana and Athi river basins.

7.5 Comparison of alternatives

From analysis of programme alternatives, it can be concluded that The “No Programme Option” will lead to a situation where the existing problems and pressures within Athi and Tana River basins will continue to obtain and this option will therefore not provide any significant advantages with regard to resource use and management. Looked at from the backdrop of pressures within the basins, planned developments and environmental benefits of the various resources within the two basins, it can be concluded that the option may further aggrevate resource use conflicts that are already problematic within the programme area.

There are a number of benefits associated with implementation of the programmes as proposed. Projects within the programme like construction of Thiba Dam will check on floods downstream and this will help in mitigating impacts associated with downstream flooding. Benefits like increase in crop production area, increase in fisheries and tourism opportunities and increase in food and income will be also be realised as a result of implementation of the programme as proposed. Employment opportunities will also be available to local people especially in water and agricultural sectors. Other benefits include improved ecological diversity particularly in upland wetlands and marsh lands like Mwea Irrigation scheme and regulation of Tana and Galana River flows. There will also be increase in food production due to irrigated agriculture, increase in fisheries and tourism opportunities and increase in income levels. The projects within the programme are also likely to open up more development within the programme area.

It is however important to note that as a result of damming, decreasing amounts of fresh water will be available to maintain ecological values and related ecosystem services such as stream migration of aquatic animals during breeding. There may also be deterioration and loss of river deltas and ocean estuaries. Hydrological alterations can affect genes to ecosystems through genetic isolation as a result of habitat fragmentation which could lead to changes in ecosystem- level processes such as nutrient cycling and primary productivity impacting negatively on biodiversity. Increased discharges from farmlands may negatively affect water quality and there is also likely to be displacement and resettlement of some residents and increase in incidents of water-borne or water-related diseases which are commonly associated with basin irrigation. More importantly, migratory patterns of wildlife may be disrupted by the reservoir and associated developments. Aquatic fauna, including waterfowl, amphibians and reptiles may increase because of the reservoir.

The "Conservation oriented alternative- Option 3" -will explore opportunities for strengthening the proposed programmes in order to enhance environmental sustainability and optimise resource use. Some of the salient features of this option include providing alternative water points to persons who may be adversely affected by the operation of the programmes as proposed; mapping all water resources and wetlands within the programme area and protecting them ; putting together some small scale irrigation schemes to form medium or large scale schemes with a provision of common intake to assist in regulating water abstractors; ensuring that any expansion or development of an irrigation project shall be storage based and building the capacity of the water users so that they are equipped with basic monitoring skills. Community dialogue will be spearheaded through establishment of more Water Resources Users Associations (WRUAs) within the programme area. This alternative is the preferred one and should be implemented by the National Irrigation Board.

7.6 Justification for the preferred alternative

The preferred alternative is justified by a number of factors that collectively contributes to its significance. To begin with, the option will lead to conservation of critical natural resources within the programme area. There are a number of wetlands within the programme area which are of great ecological and socio-economic significance. Their biodiversity includes a large number of aquatic plants, fish, herbivores and avifauna of resident and migratory birds. They are also important sources of water for human consumption, agriculture and watering of livestock. These wetlands recharge wells and springs that are often the only source of water to some rural communities. Under the proposed option, the wetlands will be mapped with the aim of protecting them from further degradation.

Implementation of the alternative will also ensure that national parks and game reserves within the programme area which act as habitats of wildlife are protected. Conflicts between humans and wildlife will be managed by creating a buffer zone between operation and wildlife areas. It will also be ensured that water needs of wildlife within their natural habitats are met by constructing water points in the form of earth dams and water pans within the wildlife conservation areas. These will ensure that wildlife will not leave there natural habitants into neighbouring land uses in search of water during dry seasons.

The preferred option will also ease pressures on the basin which have resulted from socio-economic activities as currently practiced. Some of the pressures include inappropriate land uses; overutilization of water; conversion of land to agriculture; overstocking of livestock; conversion of land to settlements; loss of catchment forests; increased demand for resources; reduced water levels; and land subdivision and fragmentation. These pressures will be managed through conservation-based agriculture.

It is also important to note that the preferred option will result in water resources conservation through putting together some small scale irrigation schemes to form medium or large scale schemes with a provision of a common intake to assist in regulating water abstractors. This will go a long way in ensuring that the available water is rationally utilized among the competing uses.

The proposed option will ensure that any expansion or development of an irrigation project shall be storage based and efforts will be made towards building the capacity of water users within the programme area so that they are equipped with basic monitoring skills. Community dialogue will be spearheaded through establishment of more Water Resources Users Associations (WRUAs) within the basin.

More importantly, irrigation under the preferred option will ensure the production of adequate food and thus improve households nutritional intake; help alleviate poverty by raising farm incomes as outlined in the National Poverty Eradication Strategy Paper; and harness women energy for agricultural production which will provide high quality vegetable protein for the community. The level of poverty in some of the counties within the basin is high hence the need to alleviate poverty through improved incomes and household food security by promoting increased level of crop production under controlled Irrigation technology. Developing the area for intensive agricultural productivity would contribute to the national food basket and reduce the import gap of some food grains. More importantly, the increase in staples and non-staple food output is likely to result in lower prices for staples and food generally leading to food security.

Employment opportunities will also be created to the local people. There are two sources of additional demand for labour created by irrigation projects generally the first being for construction and on-going maintenance of associated infrastructure (pipelines, intake weir etc). Secondly, increased farm output as a result of irrigation will stimulate demand for farm labour both within the main cropping season and across new cropping seasons, increasing both numbers of workers required and length of employment period. The positive effect of employment creation will extend to other areas as the programme is likely to reduce migration to urban areas, and so reduce the pool of urban job-seekers.

CHAPTER 8

8.0 LINKAGES WITH ONGOING PROJECTS

8.1 Introduction

A number of on-going projects are linked to the programmes under study in a number of ways including sharing common resources, sharing funding agencies and benefiting from common management institutions. The projects also find confluence with the programmes through sharing similar objectives. . The following is a summary of on-going projects linked to the programmes under study.

8.2 Ongoing projects linked with the proposed programmes

8.2.1 Lamu Port-Southern Sudan-Ethiopia Transport (LAPSSET) Corridor Project

The Lamu Port, which is one of the projects under the Lamu Port-Southern Sudan-Ethiopia Transport (LAPSSET) Corridor, is one of the infrastructure flagship projects identified by the Government of Kenya in the Kenya Vision 2030 for fast-tracking. The objective of developing Lamu Port is to provide a second sea port and transport corridor gateway link to serve the expanding import and export cargo base including the new hinterlands of northern Kenya, South Sudan and Ethiopia and also reduce over-reliance on one Port (Mombasa Port) and one Transport Corridor (The Northern Transport Corridor). The Port Master Plan will be implemented in three phases namely short term (2020), medium term (2030) within which twenty (20) berths will be developed while the other twelve (12) berths will be considered during the long term plan (beyond 2030). The development of Lamu Port will also include the construction of port associated infrastructure such as Causeway, port access road, railway yard, water and electricity supply, port building and other port related services.

Linkage with the programmes

North-Eastern, Eastern and parts of Coastal regions of Kenya have remained economically under-developed for many years. The major economic activities in these areas include pastoralism and some agriculture. The development of LAPSSET Corridor will open up the region for investment opportunities which will ultimately lead to creation of job opportunities. The anticipated substantial increases in the population of Lamu in the short to medium terms (2012-2020) and in the long term (2020-2030), respectively, will create considerable demand for goods and services in the area with a strong impact on economic activities in the hinterland and beyond. This demand, and especially for foodstuff can be met by projects associated with the programmes under study. By stimulating economic activities in various sectors, the port will strengthen economic linkages among various economic sub-sectors of the domestic economy. Increase in employment opportunities within Lamu port will lead to migration to the port hence demand for agricultural commodities (foodstuff). These will be obtained from projects associated with programmes under study.

8.2.2 High Grand Falls

The main objective of the High Grand Falls Project is to provide a large-scale multi-purpose water reservoir catering for public water supply, irrigation, river regulation, flood control and power production in order to effectively contribute to the regional and national social-economic development. The project has a reservoir storage capacity of 5.4 billion cubic metres and is to generate 700MW of power. It will provide huge benefits which include opening up huge areas for irrigation and proving fresh water supply for proposed Lamu Port through an intra and inter basin water transfer canals.

Linkage with the programme

The construction of High Grand Falls dam will promote irrigation and supply clean water in Ukambani and Tana River regions. The project is aimed at improving water supply and people's livelihoods through increased food production through irrigation, flood control and electricity generation. These are in tandem with objectives of EIP and NEP. The project will also augment water supply for irrigation purposes through harvesting of flood waters during rainy seasons and therefore helping in reducing strain that would have been experienced in the available water resources within the area. The project will therefore compliment existing water sources within the programme area and hence ensure water availability within the programme area.

8.2.3 Expansion of Mwea Irrigation Scheme

Rehabilitation and expansion of the Mwea irrigation scheme will involve rehabilitation of infrastructure which includes canals, roads and water management structures. Irrigation infrastructure is considered as a major factor of production in so far as food security is concerned and the government will continue to support its maintenance and rehabilitation in a similar manner to other infrastructure like roads. In this regard, murraming of on-farm roads and the expansion of the scheme especially in the out grower areas will be done. Upon completion of these projects, the scheme will be expanded by an additional 4000 hectares; and to double crop production thereby increasing the current annual turnover from Kshs 2.5B to Kshs 5B from rice production.

Linkage with the programmes

The expansion and rehabilitation of Mwea Irrigation Scheme will lead to increased water management and improvement of operation and maintenance of infrastructure in the scheme. Since water is a key input in irrigation, the expansion will also involve formation and strengthening of the farmers' Water Users Association for the purpose of involving farmers in scheme management. Empowerment of farmers through training and capacity building will ensure that they take up more roles in the management of the scheme. This will lead to the addressing of current challenges including water shortages and poor state of infrastructure. Planning and developing new areas where farmers have hitherto been managing the paddy fields will lead to rational water use. The program will seek synergies with this project especially with regard to funding and technical support to the community and WRUAs

8.2.4 Galana/ Kulalu Food Security Project (GKFSP)

The project is being implemented by the National Irrigation Board in order to enhance food security in the country. One of the intended results of the project is to bring down the price of Kenya's staple food (Maize). In Galana, the target is to immediately develop 500,000 acres of the vast Galana/Kulalu ranch which covers 1.75million acres but with the irrigation potential estimated to be 1.2 million acres. Due to complexity and the sheer scale of the project, implementation is being carried out in three phases. Phase I entails the establishment of a 10,000 acre model farm to demonstrate the use of high water use efficiency technologies which will be replicated in the rest of the irrigation area in the project. Phase II will see the development of a 2 billion m^3 dam and main conveyance system for 500,000 acres and Phase III will involve the development of major roads, airport, railway lines and other infrastructure.

Linkages with the Programmes

Galana Kulalu Food Security project is the main project under National Economic Programme and will lead to food security within the area and in Kenya in general. Major agricultural enterprises have been proposed for implementation under this project and these will depend on water from local water sources.

8.2.5 Construction of Thiba Dam

The proposed Thiba Dam on Nyamindi River is expected to be completed within three years of construction. The dam, once completed, shall provide irrigation water to the 7,952ha Mwea Irrigation Settlement Scheme which produces over 60 per cent of rice grown in Kenya. The scheme covers 6,660 hectares today and the dam shall enable expansion. For a long time, the Mwea Irrigation Scheme has suffered chronic water shortages. This has led the National Irrigation Board (NIB) which manages the scheme, to ration water supply to different parts of the scheme by rotation. The dam is expected to increase rice production in the scheme as it shall also entail reconstruction and rehabilitation of irrigation, drainage and other related facilities. This shall facilitate expansion of the irrigated area, improve farmers' livelihoods in the scheme, and increase food self-sufficiency in Kenya. The dam project shall also include construction of major irrigation and feeder canals up to the farms.

Linkages with the Programme

Construction of the dam will enable expansion of Mwea Irrigation Scheme. For a long time, the Mwea Irrigation Scheme has suffered chronic water shortages which have led to rationing of water to supply different parts of the scheme by rotation. The dam is expected to increase rice production in the scheme as it shall also entail reconstruction and rehabilitation of irrigation, drainage and other related facilities. This shall facilitate expansion of the irrigated area, improve farmers' livelihoods in the scheme, and increase food self-sufficiency in Kenya. This is in line with the objectives of the NEP and EIP. The program will also seek synergies with the project especially with regard to funding and technical support to irrigation farmers within Mwea Irrigation Scheme.

8.2.6 Construction of Munyu Multipurpose Dam

Munyu Multipurpose Reservoir (MMR) will have water storage capacity of 600 million cubic metres, hydropower generation of over 40 MW and irrigation potential of 30,000 ha in Athi River basin .The development will increase the current installed power by 40MW, improve horticultural exports and stimulate other sectors of the economy such as tourism and agro industrial development. Provision of water for irrigation to communities in Makueni, Kiambu and Machakos counties will also be realised.

Linkage with the programmes

The construction of Munyu multipurpose dam will promote irrigation and supply clean water within Athi River basin. The project is aimed at improving water supply and people's livelihoods through increased food production through irrigation, flood control and electricity generation. These are in tandem with objectives of EIP and NEP. The project will also augment water supply for irrigation purposes in Makueni, Kiambu and Machakos Counties through harvesting of flood waters during rainy seasons and therefore helping in reducing strain that would have been experienced in the available water resources within the area. Irrigation activities targeting horticultural crops will compliment what is envisaged in EIP and NEP. The project will also result in increase in available water within the basin and remove strain on Tana and Athi Rivers as sources of water within the two basins.

8.2.7 Tana Delta Irrigation Project

The Tana River delta and flood plain is estimated to comprise 200,000 ha of land. Out of the 200,000 ha available, 100,000 Ha is considered suitable for commercial exploitation while the local communities reserve the remainder for conservation and use. The project is planned and dovetailed towards achieving the national development goals and in particular with respect to food security. The Tana Delta Irrigation Project (TDIP) is located in Garsen Division, 110 km north of Malindi town. The project area lies on the left bank of River Tana from Sailoni in the north, where the TDIP intake is constructed. This is a rice scheme of 1800 ha expandable to 4000 ha. The objective of the project is to ensure food security, create employment opportunities and generate incomes for the local communities. Other objectives include generating revenue from sale of the produce in the local and exporting market and reducing the rice import gap thereby saving on foreign exchange.

Linkage with the programmes

The main goal of Tana delta irrigation project is to realise food security, create employment opportunities and generate incomes for the local people through cultivation of rice. These are in sync with objectives of National Economic Programme and Expanded Irrigation Programme.

8.2.8 Northern Collector Tunnel Project

The NCT 1 project is a project by the Athi Water Services Board and is located along the eastern fringes of the Aberdare conservation area approximately 60 km north of Nairobi City. The works are located in Kangema and Kigumo Sub-Counties of Muranga County. The project involves construction of river intake structures at Maragua, Gikie and Irati rivers; construction of access adits at Gikigie, Irati and Kaanja; and construction of 11km long, 3.0 diameter main water tunnel from Maragua intake to Githika outfall. The tunnel will be fully concrete lined. The other program components involve construction of high level Water Treatment Plant at Kigoro and the water transmission pipelines to Nairobi City of capacity of 140,000m^3/day; construction of Muranga and Kiambu County community water supply projects to ensure water supply to host communities is also improved; construction of Nairobi city water distribution network to ensure equitable distribution and improvement of water services in Nairobi satellite towns within Kiambu and Kajiado Counties.

Linkage with the programmes

The collector tunnel project intends to improve water services in Nairobi city and this may have some impacts on available water for competing uses within the basin. The project will depend on water from rivers that feed River Tana and this may impact on water available within Tana River basin for competing uses.

8.2.9 Thwake Multi-Purpose Dam

The Thwake Multi-purpose Water Development Program (TMWDP) comprises a multi-purpose dam for water supply, hydropower generation and irrigation development. The project is an initiative of TARDA and will also provide regulation of flows on Athi River downstream of the dam for flood and drought mitigation. The TMWDP targets broad improvement in productivity and livelihoods over a ten-year period, ending 2023. The Program recognizes the symbiotic relationship between Kenya's water secure and water insecure regions by spanning both the lower and higher levels of the economy to ensure national economic growth is both inclusive and sustainable. The project will be implemented in four phases. Phase 1 includes: consultancy services for design and supervision of works; construction of a 77 m high rockfill dam and associated structures; catchment rehabilitation / protection; studies and designs for subsequent phases and to enhance phase 1 implementation; climate change training; and technical assistance. Dam construction is expected to be completed by December 2018. The beneficiaries are mainly the rural population of two semi-arid counties and the urban population of the upcoming ICT city of Konza (in total about 1.3 million people). In phase 1, the program will increase water security by providing 681 million cubic metres (MCM) of water storage, earmarked for phases 2, 3 and 4 as follow: 34 MCM for human consumption, 625 MCM for double usage (power generation and downstream irrigation), 22 MCM for upstream irrigation, and an allocation for downstream conservation flow. The target population will benefit from an abundant supply of potable water which will lead to improved health and also spur economic development throughout the area and in Konza City.

Linkage with the programmes

The dam will provide water for various uses including irrigation development. The project will therefore contribute to food security and employment creation among residents of the programme area.

8.2.10 Mt Kenya Ecosystem Management Plan, 2010-2020

This plan was funded under the Mount Kenya East Pilot Project for Resource management/ Global Environment Facility (MKEPP-GEF) project, and involved KWS, KFS, WRMA, KEFRI, and NEMA. The ten year plan follows the KWS Protected Area Planning Framework (PAPF) which adopts an ecosystem approach to plan development and implementation with a view to addressing conservation issues holistically and actively involving local communities and other stakeholders in ecosystem conservation and management. The plan has seven main programmes including ecological Management Programme; forest Resource Management Programme, water Resource Management Programme, tourism Development and Management Programme, Community Partnership and Education Management Programme, Security Management Programme and Protected Area Operations Programme

Linkage with the programmes

EIP and NEC will have linkages with the management plan with regards to ecological management through habitat restoration and protection; forest resource management through promoting participatory forest management ; water resources management through controlled water abstraction, and conservation by controlling illegal abstraction, riparian cultivation, pollution and siltation of rivers and dams, and soil erosion. Community partnership and education programme will help in reducing human-wildlife conflicts.

8.2.11 Community irrigation projects

These are community projects targeting areas of between 50 and 500 acres. They include Kiaga Irrigation Scheme, Mwiria Irrigation Scheme, Karia Irrigation Scheme - Kirinyaga County, Kaithewa Irrigation Scheme- Kirinyaga County. Kiaga is a 400 acre irrigation project funded by IFAD. The project intends to get water from River Rupingazi while Mwiria is a 185 acre irrigation project that is funded through the cooperation between IFAD and Mwiria farmer's cooperative society and will get water from Nyanjara River (a tributary of River Rupingazi). Karia irrigation scheme targets 150 acres of land for horticulture irrigation getting water from Ruture River while Kaithewa scheme targets 75 acres of land for horticulture irrigation Sourcing water from Ruture River. Greater Kibwezi Irrigation scheme and Lower Athi Irrigation Scheme are projects of TARDA. Greater Kibwezi irrigation project targets 150 hectares of land to be put under irrigation and is funded by TARDA. Project will source water from Kiboko River while Lower Athi Irrigation Scheme is a TARDA/CIDA project which targets to source water from Tsavo River.

Linkage with the programmes

These projects will abstract water from rivers within Tana and Athi river basins which are the main tributaries of Tana and Athi Rivers. Some of the projects will also be implemented through cooperation of the local communities and the National Irrigation Board. The programs may therefore seek synergies with the project especially with regard to funding and technical support.

8.2.12 Projects by County Governments

Some County governments also have plans to put up various projects within the basin. Some of the projects include Modernization of KIRIWASCO water supply network, a project funded by KIRIWASCO and targets to supply clean water to more residents of Kerugoya and Kutus towns and construction of Kiserian Dam. Modernization of KIRIWASCO water supply network will source water from Ruture River. Kiserian dam is a project of Kajiado County government and targets to provide domestic water to Kiserian and Ongata Rongai Towns. The dam will be constructed along Nkoroi River.

Linkage with the programmes

These projects are linked with the programmes in the sense that they will get water from rivers within the programme area and these rivers are the main tributaries of Tana and Athi Rivers. The proposed dam will provide water for various uses including irrigation development. The project will therefore contribute towards food security and employment creation among residents of the programme area. Food security is a major objective of NEP and EIP.

CHAPTER 9

9.0 RECOMMENDATIONS

9.1 Recommended PPP changes

From the field findings during the SEA study, it was realised that the programme area has various pressures that may not make it possible for the programmes to be implemented as proposed. The following changes should be made to the programmes to increase their environmental sustainability and social acceptability.

(vi) There is need of putting together some small scale irrigation schemes envisaged in the programmes to form medium or large scale schemes with a provision of common intake to assist in regulating water abstractors and make it manageable in providing water, especially if storage has to be put in place;
(vii) A metering system should be put in place for every farmer to ensure effective management of the water use. When there is no metering, there is a tendency of water misuse by the local farmers as people are not individually responsible for their actions;
(viii) There should be a deliberate move to create storage in all rivers where good sites of dams exist so that the flood water can be stored and later used for irrigation during dry periods;
(ix) Any expansion or development of an irrigation project within the programme area should be storage based since water resources within the two basins are already strained as a result of competing uses. No project should be allowed to proceed to implementation phase without provision for storage;
(x) Local farmers should be encouraged to use drip method of irrigation as much as possible due to water scarcity within the programme area and need to irrigate more area. Sprinklers should be used as alternative sources in situations where use of drip method is not possible;
(xi) Efforts should be made towards using wind and solar energy as an effective alternative for hydroelectric power in pumping in order to avoid long term expenses associated with pumping;
(xii) There should be a continuous and systematic capacity building of community members within the irrigation schemes. Capacity of farmers should be built on water management, environmental conservation and operation and maintenance of irrigation infrastructure. This will ensure sustainability in the long run;
(xiii) Illegal abstractors must be controlled through river basin patrols and all abstraction points should be destroyed and persons found to be illegally abstracting water from local rivers made to account;
(xiv) Conservation and protection of wetland resources should form part of programme activities. Wetlands within the programme area should be mapped and protected in order to reap ecological and other benefits associated with these areas; and
(xv) Local communities should be actively involved in the project activities and be made part of the decision making process on matters linked to the programmes. Catchment destruction should be controlled and the areas conserved by involving local stakeholders in environmental conservation process.

9.2 Recommended mitigation measures

9.2.1 Mitigation measures for impacts related to agricultural expansion

(i) Consider options of providing water to the residents who may be adversely affected by the implementation of the proposed programmes. This may include setting aside some funds to sink boreholes for the affected individuals and protect local springs;
(ii) Map all water resources and wetlands within the programme area and protect them from degradation in compliance with existing rules and regulations. The process of mapping prevents further destruction of water resources thereby contributing to water flow, maintaining biodiversity of the area and covering some of the shortfalls in water demand;
(iii) Project areas should be fenced off and some corridor left to facilitate wildlife movement to the local rivers. Corridors should also be left between project areas and wildlife dispersal areas especially for projects bordering National Parks and Game Reserves; and
(iv) Training should be provided to local farmers on fertilizer and pesticides use.

9.2.2 Mitigation measures for impacts related to abstraction of water from the local sources

(i) Put together some small scale irrigation schemes to form medium or large scale schemes with a provision of common intake to assist in regulating water abstractors;
(ii) A system of metering for every farmer should be put in place to ensure effective and efficient management of water use.
(iii) There should be a deliberate move to create storage in all rivers where good sites of dams exist so that the flood water can be stored and later used for irrigation during dry periods;
(iv) Any expansion or development of an irrigation project within programme area should be storage- based since some of the water sources are strained (storage first);
(v) Adequately compensate affected persons for any resource lost as a result of proposed programme activities. This should be achieved through proper valuation of resources affected;
(vi) Reduce illegal abstractions, especially in the upstream section of the River Tana by bringing illegal water users into the permit system;
(vii) Regular patrolling should be done since it discourages illegal use and ensures that water abstractions are in line with legal provisions; and
(viii) Build the capacity of the water users so that they are equipped with basic monitoring skills. Monitoring on the ground will help the water users to better understand the signs of shortages and pollution and thereby play a constructive role in equitable allocation and improvement of water resources quality.

9.2.3 Mitigation measures for catchment degradation

(i) Spearhead community dialogue through establishment of more Water Resources Users Associations (WRUAs).This can be coordinated by Water Resources Management Authority. Involvement of water users will create ownership at local level and trigger new dynamics to solve conflicts.

9.2.4 Mitigation measures for impacts related to competition for resources

(i) Reduce illegal abstractions, especially in the upstream section of the River Tana through bringing illegal water users into the permit system;
(ii) There should be a deliberate move to create storage in all rivers within the programme area where good sites of dams exist so that flood water can be stored and later used for irrigation during dry periods;
(iii) Project areas should be fenced off and some corridor left to facilitate wildlife movement to the local rivers. Corridors should also be left between project areas and wildlife dispersal areas especially for projects bordering National Parks and Game Reserves.

9.3 Recommended alternative

The option that has been recommended for implementation is the conservation oriented alternative (Option 3). This option has explored opportunities for strengthening the proposed programmes in order to enhance environmental sustainability and optimise resource use. Under this alternative, technologies for water harvesting, farming methods to be used, linkage of farmers to the market, agricultural mechanization, existing farm sizes and provision of input and credit to farmers have been analysed. Irrigation and technologies for water harvesting as they relate to adoption of innovative concepts have also been analysed. Irrigation intensification has been considered in terms of application of best practices towards utilization of developed irrigation space and scarce water to realize better crop production. The applicable modern irrigation technologies have been looked at from the point of view of improvement of efficiency in water use.

Farming methods have been looked at from the backdrop of the effects of adverse climate change, erratic rainfall patterns and need to enhance agricultural productivity while provision of inputs and credits to farmers has been considered from the point of view of economic conditions of the local farmers and the extent to which they require support to engage in profitable agricultural practices. Mechanization of agricultural production is considered as a platform upon which efficiency in crop husbandry can be improved. The linkage of agricultural mechanization to farm sizes has been critically looked at taking due consideration of decreasing farm sizes due to subdivisions.

Some of the salient features of this option is providing alternative water points to persons who may be adversely affected by implementation of the programmes as proposed; mapping of all water resources and wetlands within the programme area and protecting them ; putting together some small scale irrigation

schemes to form medium or large scale schemes with a provision of common intake to assist in regulating water abstractors; ensuring that any expansion or development of an irrigation project should be storage based and building capacity of water users so that they are equipped with basic monitoring skills. Community dialogue will be spearheaded through establishment of more Water Resources Users Associations (WRUAs) within the programme area.

9.4 The need for subsequent Environmental Impact Assessments (EIAs)

9.4.1 General

There are a number of projects falling under programmes whose future implementation may lead to significant environmental impacts which can only be addressed through an elaborate process of project level Environmental Impact Assessment.

9.4.2 Projects to be subjected to Environmental Impact Assessments

The following is a summary of projects within Tana and Athi river basins that will require project level EIAs during their periods of implementation.

9.4.2.1 Major agricultural activities (Galana-Kulalu Food Security Project)

The environmental impacts of agricultural projects vary based on the wide variety of agricultural practices employed by farmers. Ultimately, the environmental impact depends on the production practices of the system used by farmers. The connection between emissions into the environment and the farming system is indirect, as it also depends on other climate variables such as rainfall and temperature. The environmental impact of agriculture involves a variety of factors from the soil, to water, the air, animal and soil diversity, people, plants, and the food itself. Some of the environmental issues that are related to agriculture are climate change, deforestation, genetic engineering, pollutants, soil degradation, and waste. Under the National Economic programme, the enterprises that will need to be subjected to project level EIAs include sugarcane and maize enterprises. One of the factors informing this decision is the geographical area to be covered by these projects. In sugarcane enterprise for example, a total of 311,731 acres will be put under sugarcane farming while a total of 525,253 acres will be put under irrigated maize production. These enterprises will also depend on irrigation and it would therefore be necessary to know how this may affect water availability for competing uses.

9.4.2.2 Urban development

There are a number of environmental issues that are associated with urban development and these needs to be critically looked at through an Environmental Impact Assessment study. Some of the key issues in these projects include transportation/car dependency; infrastructure deficit; air quality; drinking water, wastewater and stormwater quality; and solid waste management. All projects with urban development

component should undergo project-level EIA. The proposed new town in Galana-Kulalu which is expected to sit on a total of 117,805 acres of land may be associated with various environmental and social impacts and will therefore require a project level EIA.

9.4.2.3 Tourism Development

Galana-Kulalu food Security Project envisages development of tourist resort. Within the Urban Development Model (zone 28), a modern resort is proposed. The resort will be designed to include sports facilities such us golf and holiday homes. These may have adverse impacts on social and environmental elements and need to be subjected to project-level EIA.

9.4.2.4 Large scale irrigation/agricultural projects with area coverage of more than 2000 acres

Socio-economic activities as currently practiced within the Tana River basin have led to pressures including inappropriate land use; overutilization of water resources; conversion of land to agriculture; overstocking of livestock; loss of catchment forests; increased demand for resources; reduced water levels; and land subdivision and fragmentation. In Athi River basin, pressures include over-exploitation of surface and ground water resources; wetlands resources degradation; unregulated diversions of river channels; catchment degradation due to overgrazing and sand harvesting; land use changes for settlement and agriculture; and climate change and variability. There is therefore need to find out how any proposed project may aggrevate these pressures. Any agricultural project covering more than 2000 acres may have impacts that can only be assessed through an elaborate EIA process.

9.4.2.5 Projects that involve displacement of populations

Every effort should be made to avoid or minimize the need for involuntary resettlement. A thorough analysis of project alternatives should be carried out in order to identify solutions that are economically and technically feasible while eliminating or minimizing the need for involuntary resettlement. In examining the trade-offs between alternatives, it is important to have a reasonable estimate of the numbers of people likely to be affected, and an estimate of the costs of resettlement. Particular attention must be given to socio-cultural considerations, such as the cultural or religious significance of the land; the vulnerability of the affected population; or the availability of in-kind replacement for assets, especially when they have important intangible implications. When a large number of people or a significant portion of the affected community would be subject to relocation and/or impacts affect assets and values that are difficult to quantify and to compensate, after all other options have been explored; the alternative of not going ahead with the project should be given serious consideration. This can only be done through a project-level EIA.

9.4.2.6 Development of major water storage dams

Dams are mainly aimed at making positive impacts including improving water supply and people's livelihoods through increased food production through irrigation; flood control and electricity generation as

applicable. Dams however have a number of negative impacts which should not be ignored. Some of the potential negative impacts associated with dams include biodiversity loss (wildlife, agro-diversity); food insecurity (crop damage); soil erosion, deforestation and loss of vegetation cover; surface water pollution / decreasing water (physico-chemical, biological) quality; groundwater pollution or depletion; large-scale disturbance of hydro and geological systems; and reduced ecological / hydrological connectivity. Socio economic impacts include displacements; loss of livelihood; specific impacts on women; and loss of landscape/sense of place among others. Construction of dams especially upstream of Tana River basin will reduce the amount of water flowing into Tana delta from River Tana. This would hasten and exacerbate changes in downstream ecosystem and biodiversity, further disrupting the flooding regime, which has already been disrupted by existing dams; and also affect livelihoods for farmers, fishermen and pastoralists within the Delta who depend on the flooding system of the river for their source of livelihoods. All impacts associated with dam construction can be analysed through project-level EIA.

CHAPTER 10

10.0 ENVIRONMENTAL MANAGEMENT AND MONITORING PLAN (EMMP)

10.1 Environmental Management Plan (EMP)

10.1.1 General

The key outcome of the Strategic Environmental Assessment for Athi and Tana River basins is the Environmental Management Plan (EMP). This EMP is an instrument that will allow NIB, private developers, regulatory agencies and other key stakeholders to integrate environmental components during implementation of the various components of the programmes under study.

10.1.2 Scope and Objectives of the EMP

This EMP focuses on mitigating the impacts identified during the strategic environmental assessment process. It is an instrument that will allow NIB, private developers, regulatory agencies and other key stakeholders to integrate environmental components during the various phases of the programmes. This plan is meant to establish measures and procedures to control the identified impacts and monitor their progress. It will achieve the following in the long run:

(i) Provide the National Environment Management Authority (NEMA) with a tool to make ease the evaluation of the objectives at different phases of the programmes taking into account the Kenyan environmental legislation;
(ii) Provide clear and mandatory instructions to the National Irrigation Board, private developers, regulatory agencies and other key stakeholders with regard to their environmental responsibilities in all phases of the programmes;
(iii) Ensure continuous compliance of NIB, private developers, regulatory agencies and other key stakeholders with Kenyan legislation and policies regarding the environment; and
(iv) Assure the regulators and interested and affected parties the satisfaction of their demands in relation to environmental and social performance.

10.1.3 Applicable Legislation

The pieces of legislation applicable to the Environmental Management Plan are described in Chapter four of this SEA Report. International normative instruments concerning the environment, as well as international best practices have also been considered.

10.2 Principles of Environmental Management Plan

The programmes should be implemented taking into account the need to minimize potential negative impacts and maximize their potential positive impacts on the biophysical and socio-economic environment as well as health and safety of workers and the public .This commitment must be made at various levels, from the senior management level of the proponent to the levels of all parties involved in the implementation of the programmes.

10.3 Recommendations/Commitments of the SEA

The SEA contains a series of recommendations related to mitigation measures, monitoring and environmental management. A key role of the EMP is to put them all in a single framework. For each identified impact in the SEA, the EMP provides in a tabular format the following:

(i) A list of mitigation measures (activities) that the proponent and other key stakeholders will implement in accordance with each phase and activity of the programme, to ensure that the mitigation objectives are met in full;
(ii) The role and responsibility of each of the stakeholders to ensure full implementation of mitigation measures; and
(iii) The timetable of implementation/monitoring activities.

10.4 Environmental Awareness

The key stakeholders in the project will be sensitive to the needs of the environment so as not to degrade (or degrade to a minimum) the existing environmental conditions. The proponent will take the lead in ensuring that all parties who are directly involved in the construction and operation phases of the projects under the programmes, including managers and employees are aware about the need to prevent or minimize environmental degradation. The awareness activities will be guided by the following issues:

(i) Prevention of pollution of surface water and groundwater;
(ii) Prevention of air quality degradation;
(iii) Prevention of increased noise levels;
(iv) Prevention/reduction of social and economic disruptions; and
(v) Prevention of risks to health and safety of workers and the general public.

10.5 Mitigation Measures

All activities related to the lifecycle of the programmes will be subjected to appropriate mitigation measures to ensure that negative impacts are properly mitigated and managed. Mitigation involves identifying the best options to be adopted to minimize or eliminate negative impacts, highlighting the benefits associated with the programmes and the protection of public and individual rights. Practical measures are therefore sought to reduce adverse impacts or enhance beneficial impacts of the programmes.

10.6 Monitoring

The key objectives of monitoring are:

(i) To ensure that the EMP is implemented;
(ii) To evaluate the effectiveness of the mitigation measures;
(iii) To verify predicted impacts; and
(iv) To provide feedback to licensing authorities.

10.8 Responsibilities in Environmental Management

10.8.1 General

National Irrigation Board, private developers, beneficiary communities and regulatory agencies are the main entities responsible for implementing this EMP. In the interest of environmental protection, health and safety of workers and the public, and in their own interest, NIB, private developers and beneficiary communities will include in their contractual arrangements with contractors, clauses relating to environmental protection -and, specifically, compliance with the EMP - that will safeguard the right to require them of the contractors' compliance with environmental requirements and social action in case of breach.

10.8.2 Responsibilities of National Irrigation Board (NIB)

National Irrigation Board will ensure that all project operations are conducted in accordance with their internal environmental policies and in accordance with the EMP. NIB in partnership with the contractor and other key stakeholders will ensure that the EMP and other requirements related to health, safety and environment are implemented in full. NIB will strive to manage operations in a manner to protect the environment and health and safety of employees, contractors, consumers and the general public. To achieve this objective, NIB will:

(i) Obtain authorizations/approvals/licenses required for project implementation;
(ii) Request the contractor to operate on the basis of valid authorizations/approvals/ licenses for the activities to be implemented by them;
(iii) Ensure that the EMP is an integral part of the contract document with the contractor and that the contractor will be responsible for its implementation;
(iv) Establish institutional linkages with relevant parties in the project implementation as needed, or designate a representative for that purpose;
(v) Ensure that the various programme activities comply with the mitigation measures proposed in the Environmental Management and Monitoring Plan(EMP);
(vi) Make regular inspections to all the different activities with regard to social aspects, health, safety and environment and check for any non-conformity with the EMP attributable to the Contractor and identify the steps taken for its correction;
(vii) Monitor the performance of their own teams, or designate a representative to that effect;
(viii) Approve work procedures established for each phase of the project and ensure that the various activities are implemented in accordance with them;

(ix) Establish and implement a complaints management procedure that allows their treatment/appropriate response to them;
(x) Ensure that any corrective activities recommended by the audits or inspections (performed internally or externally) are implemented within the time pre-set.

10.8.3 Responsibilities of Private Developers

Private Developers will ensure that all project operations are conducted in accordance with their internal environmental policies and in accordance with the EMP. They will partner with contractors to ensure that the EMP and other requirements related to health, safety and environment are implemented in full. Private Developers will strive to manage their operations in a manner to protect the environment and health and safety of employees, contractors, consumers and the general public. To achieve this objective, Private Developers will:

(i) Obtain authorizations/approvals/licenses required for project implementation;
(ii) Request the contractor to operate on the basis of valid authorizations/approvals/ licenses for the activities to be implemented by them;
(iii) Ensure that the EMP is an integral part of the contract document with the contractor and that the contractor will be responsible for its implementation;
(iv) Establish institutional linkages with relevant parties in the project implementation as needed, or designate a representative for that purpose;
(v) Ensure that the various programme activities comply with the mitigation measures proposed in the Environmental Management and Monitoring Plan(EMP);
(vi) Make regular inspections to all the different activities with regard to social aspects, health, safety and environment and check for any non-conformity with the EMP attributable to the Contractor and identify the steps taken for its correction;
(vii) Monitor the performance of their own teams, or designate a representative to that effect;
(viii) Approve work procedures established for each phase of the project and ensure that the various activities are implemented in accordance with them;
(ix) Establish and implement a complaints management procedure that allows their treatment/appropriate response to them;
(x) Ensure that any corrective activities recommended by the audits or inspections (performed internally or externally) are implemented within the time pre-set.

10.8.4 Responsibilities of the Contractors

All Contractors will identify individuals responsible for overall management of the environment, social management, safety and health management during all operations. The Contractors shall be responsible for relevant training of their staff, which must be able to complete the programme activities in an efficient and appropriate manner in accordance with the contractual requirements of NIB to the agreed work. Among many tasks, the contractors shall:

(i) Prepare their own EMP implementation plan as well as a health and safety plan within 30 days of signing of the contract. The EMP implementation plan must be submitted to the representatives of the National Irrigation Board (NIB) or any other funding agency for approval prior to the initiation of construction works;
(ii) Submit to the proponent the work procedures/methods or equivalent documents for approval;
(iii) Operate on the basis of valid licenses/approvals/authorizations for activities to be implemented;
(iv) Employ techniques, practices and construction methods to ensure compliance with the EMP;
(v) Prevent or minimize the occurrence of accidents which might cause damage to the environment and be able to respond positively to an accident if it occurs;
(vi) Meet the working procedures and environmental requirements and health and safety requirements established by contract with the Proponent; ensure compliance with them by sub-contractors who might be hired by them;
(vii) Minimize environmental damage, waste control, avoid pollution, prevent loss or damage on natural resources and minimize the effects on the users and occupants of surrounding lands and the public;
(viii) Provide Personal Protective Equipment (PPE) to workers which are appropriate to the tasks to be performed and ensure that they are used;
(ix) Implement all corrective activities agreed in audit (internal or performed by other agencies) or inspections, within the pre- established deadline;
(x) Manage the complaints process on the elements that fall within their jurisdiction, or refer complaints to the Proponent, so that they can receive treatment/appropriate response; and
(xi) Prepare a Rehabilitation Plan which shall include preliminary designs on the temporary and permanent landscaping plan during both the construction and post-construction and maintenance period (where applicable).

10.8.5 Responsibilities of Beneficiary communities

Beneficiary communities will ensure that all their operations are conducted in accordance with the EMP. They will also ensure that the EMP and other requirements related to environmental protection, safety and health are implemented in full in order to protect the environment, health and safety of workers, contractors, consumers and the general public. To achieve this, beneficiary community will do the following:

(i) Plan their activities, aiming to eliminate or minimize impacts in the environment, through preventive activities or mitigation measures;
(ii) Establish periodic maintenance of the system within their areas of jurisdiction to reduce the risks associated with pipe rupture and system malfunction;
(iii) Develop strategies for environmental management and ensure they comply with environmental laws, implement pollution prevention programs, manage instruments to correct environmental damage, tailoring products to the ecological specifications, and monitor their environmental program; and
(iv) Meet all the requirements of environmental laws and regulations applicable to the project.

10.8.6 Responsibilities of Regulatory Agencies

Regulatory agencies directly involved in this project include among others Water Resources Management Authority (WRMA), National Environment Management Authority (NEMA) and Kenya Wildlife Services (KWS).

10.8.6.1 Water Resources Management Authority (WRMA)

Water Resource Management Authority (WRMA) is a state corporation under the Ministry of Environment, Water and Natural Resources established under the Water Act 2002 and charged with being the lead agency in water resources management. The Authority through Regional offices for Tana and Athi basins will carry out the following mandates under this EMP:

(i) Develop principles, guidelines and procedures for the allocation of water resources within the programme area;
(ii) Receive and determine applications for permits for water use;
(iii) Determine and collect charges for water use;
(iv) Monitor and enforce conditions attached to water permits and water use;
(v) Regulate and protect water resources quality from adverse impacts;
(vi) Gather and maintain information on water resources and from time to time publish forecasts, projections and information on water resources;
(vii) Liaise with other stakeholders for the better regulation and management of water resources;
(viii) Regulate and protect water resources from adverse impacts;
(ix) Regulate water infrastructure, use and effluent discharge;
(x) Work with the beneficiary communities to manage and protect water catchments;
(xi) Constitute and support WRUAs; and
(xii) Establish water resources monitoring networks

(b) Kenya Wildlife Service (KWS)

The Kenya Wildlife Service is a state corporation that was established in 1990 to conserve and manage Kenya's wildlife. It is established under an Act of Parliament Cap 376 (The Wildlife Conservation and Management Act) with the mandate to conserve and manage wildlife in Kenya, and to enforce related laws and regulations. It manages the biodiversity of the country, protecting and conserving the flora and fauna. Under the programme, KWS will carry out the following:

(i) Partner with local communities to help in the conservation of plants and animals within the programme area;
(ii) Partner with local people in their programmes that assist Kenyan species and habitats that are in particular danger. The local people should be integrated into the forest and Wetland conservation programmes to help in conservation of these resources for posterity;

(iii) Community wildlife service department of KWS should work in areas such as wildlife corridors, and teach local communities living there to encourage conservation and manage incidents of human-wildlife conflicts; and
(iv) The KWS security service department should work towards eliminating poaching in the national parks, and stop illegal trade.

(c) National Environment Management Authority (NEMA)

NEMA is the institution that plays a greater role in the process since it is responsible for taking decision on the EIA process and responsible for regulating the environmental performance of projects in Kenya. They are also responsible for verification, inspection and audit, before, during and after the implementation of projects (in accordance with EMCA 1999). NEMA should therefore ensure that programme activities comply with applicable environmental laws and regulations.

10.8.7 Responsibilities of Independent Auditors

NEMA represented by Sub County Environment Officers must request for environmental audits or inspections to verify compliance with the mitigation measures contained in this report. The Contractor must submit an Environmental Management Report every three months, with the results of quarterly monitoring. It is recommended that environmental monitoring is carried during project implementation period and audits carried out one year into operation phase of the project in order to verify compliance with the stipulations of the EMP.

10.9 Environmental Management Framework

Management of environmental resources within the programme area should be done in a framework that addresses the needs of the local people while at the same time ensuring conservation and protection of environmental resources. To ensure sustainability, the following plans should be put in place during implementation of projects under the programmes.

10.9.1 Information, education and communication plan

10.10.1 Capacity building

Community capacity building is imperative. The recommended capacity building interventions and training should begin with capacity building and training needs assessment and aim to focus on (i) Gender mainstreaming in irrigation development; (ii) Community development and organization to establish and strengthen the IWUAs and WRUAS for effective management of the water resources and operations and maintenance of the irrigation infrastructure.

10.10.2 Environment and soil conservation

Create awareness and educate the farmers on soil conservation by introducing conservation agriculture, use of available organic matter, crop rotation and education to ensure soil conservation principles are applied during agricultural practices. Farmers should also be taught about environmental conservation that can be achieved through controlling pollution, planting friendly trees, bench terracing and avoiding farming on steep slopes. The community members should be encouraged to plant friendly trees and avoid encroaching on wetlands over and above avoiding cultivation along the rivers in order to protect the water catchment areas. Accordingly tree seedlings for agroforestry trees should be made available to farmers.

10.10.3 Irrigated farming

There is need to allocate more resources to the agriculture sector to enhance technologies such as irrigation because farmers are faced with the challenges of climate change and rainfall is no longer predictable and reliable. With irrigation, farmers will need technical support from extension workers and agriculture experts. To improve farmers' capacity and make agriculture and marketing information available to the farmers, additional extension officers should be engaged within the programme area. Irrigated farming will combine crop farming for domestic food supply and sale of surplus produce. Livestock farmers should be encouraged to grow browse crops too.

10.9.2 Social Development Plan

10.2.1 Assess social factors that affect beneficiary participation

Social analysis study should be conducted to understand the intensities of community organization, gender disparity, child labor practices, and cultural practices to be addressed in mitigation against any negative impacts brought about by the project. There are social dynamics in areas of gender and social economic obligations that have a direct impact on the programmes and these need further investigations. More studies on social and gender analysis should be conducted during programme implementation to bring out issues related to access to land and all other necessary resources to make sure that men, women, vulnerable people and youths are engaged and involved in the project in order to accrue benefits.

10.2.2 Ensure gender balancing in the project benefits and involve the youth

There is need to promote women, men and youth participation and decision making in the programmes and further identify factors that limit equal participation and define how gender issues are to be incorporated. Specific strategies should be developed for each interest group and any existing gaps reduced. Youth women and the vulnerable groups should be involved in all aspects of the projects under the programmes and it should be ensured that they benefit from land resource and all other resources within the programme area.

10.9.3 Institutional Plan

10.3.1 Public and private sector partnership

It is envisaged that the Irrigation water user association (IWUA) will be responsible for maintaining the irrigation infrastructure hence farmers will pay a tariff for operations and maintenance. It is also of essence to explore the possibility of engaging a private operator to be responsible for operating and maintaining the entire systems and farmers pay a higher tariff that reflects the costs associated with this.

10.3.2 Stakeholders Forum

The programme should adopt a participatory approach which should be advanced by identifying all stakeholders at the community level, County government level, National government level and private sector. An inventory of all stakeholders should be developed to form a stakeholders' database. All stakeholders should be systematically involved in consultative meetings to maintain dialogue for the benefit of the programme and beneficiaries.

10.9.4 Contingency/emergency response plan

10.4.1 Parallel programs to mitigate all negative effects of programme

Under the irrigation projects, major intervention should be undertaken in mitigation against challenges brought about by the influx of business people to the region. This is expected to bring with it negative effects such as increased school dropout rates, early pregnancies and marriages, increased rates of HIV infections, health hazards brought by pesticides, insecticides and fungicides to the water, stagnant water where larvae breeds, etc. The programme must look into ways of mitigating against the negative effects. A parallel programme should be started that will intervene by controlling larvae breeding for malaria control, promote safe drinking water through domestic water supply, promote hygiene and environment conservation and educate and carry out campaigns to stop the social vices associated with programme implementation among others.

Table 10. 1: Framework Environmental Management Plan for Irrigation Projects

Project Activities	Potential Impact Description	Mitigation/ Enhancement Measures	Cost in KES of Mitigation /Enhancement	Responsibility	Frequency	Verifiable Monitoring Indicators
1. Planning and Construction Phase						
Construction works	Soil erosion	Return and compact soil after laying of pipes	KES 50,000 per Km	Project Manager/WRUA	Once	Record of pipes laid
	Water pollution at intake	Minimum excavation works, consider temporary diversion during construction	KES 200,000 per site	Project Manager/ Contractor	Once	Constructed weir and intake, reports of construction
2. Operations Phase						
Water distribution and use by farmers	Water losses	Repair of bursts; regular maintenance	KES 20,000 per month per site	Project Manager	Day-to-day	Record of repairs undertaken; records of bursts
	Over-abstraction	Metering of abstraction; considerations to river flow rates	KES 10,000 per month per site	Project Manager / WRUAs	Day-to-day	Readings of master meter and other meters
	Water wastage	Ensure water efficiency, ensure only agreed land areas irrigated	KES 20,000 per site to ensure compliance among members	Project Manager/ Committee	Day-to-day	Water efficiency by farmers
	Reduced water downstream and water use conflicts	Ensuring there is no over-abstraction by metering and consideration of river flow rates	KES 10,000 per month per site	Project Manager / WRUAs	Day-to-day	Master meter reading and river flow rates
	Water logging and	Installing adequate	Farmers cost	Project Manager	Day-to-day	Installed drainage

	salinization	drainage systems; training		/WRUAs		systems
	Pollution from agricultural biocides; eutrophication of water bodies	Farmers training on use of chemicals; integrated pest management	KES 100,000 per site for training	MoA/Project Manager/ WRUAs	Day-to-day	Record of farmers trained, water tests
	Soil erosion and siltation from intakes	Regular cleaning of intakes	KES 20,000 per month per site	Project Manager/WRUA	Monthly	Clean intakes
3. Health and Safety						
Operations	Incidence of water-borne and water-related diseases: - malaria, bilharzia (schistosomiasis) and river blindness (onchocerciasis)	Pathogen immunization; vector control by chemical sprayings; and reduce human/vector or human/pathogen contact: health education, personal protection measures and mosquito proofing of houses	KES 20,000 per annum per site	Project Manager Ministry of Health	Day-to-day	Training undertaken; reports on incidences of diseases
4. Socio-economic						
All activities	Employment creation	Using human manpower as much as possible	No extra costs	Farmers/ WRUAs	Year long	Records of hired manpower and remuneration
	Wealth creation and Improved incomes	Promoting uptake of agricultural activities and building technical capacity and marketing skills	KES 50000 per year per site for capacity building; KES 20,000 per site for market information and linkages	Project Manager	Year long	Records of numbers of locals who have taken up irrigation, rice growing and horticulture; markets and incomes accruing to communities

Table 10. 2: Framework Environmental Management Plan for Boreholes

Project Activities	Potential Impact Description	Mitigation/ Enhancement Measures	Cost of Mitigation /Enhancement	Responsibility	Frequency	Verifiable Monitoring Indicators
1. Pre-Drilling & Drilling/Construction Phase						
Siting of borehole,	Improper siting	Hydro-geological survey	KES 150,000 per site	Geologist	Once, beginning of project	Hydro-geological report
Application of permit	Drilling illegally	Seeking permit from the Ministry of Water and Irrigation	KES 200,000 per site	Project Manager	Beginning of project	Water permit
Receiving bids from contractors	Undertaking unprofessional drilling works	Seeking qualified and registered water engineer/ borehole drilling contractor	KES 1.5 million per site	Project Manager	Once and when maintenance required	Drilling contract
2. Operation and Maintenance Phase						
Mobilization of equipment and clearing	Vegetation destruction, , noise, dust	Replacing removed vegetation	KES 50,000 per site	Project Manager	Beginning and when required to replace	Planted vegetation
Drilling and tank construction	Dust, solid/liquid wastes, noise, blowout	Watering of borehole area, use of re-circulation equipment,	KES 150,000 per site	Contractor	Once	Records from contractor confirming purchase and use of mitigations measures
Water abstraction	Over-abstraction of ground water	Abstraction of a Maximum allowed quantity per day and this will only be during peak periods. Peizometer and water meter.	KES 50,000 per site	Contractor, project manager,	Monthly review	Water meter/ peizometer readings per month

	Ground water pollution, mud hole around well	Complete sealing from ground level into rock-head; Installing a PVC casing & slotted screen; Constructing a concrete pad around the well to keep contaminated surface water away from the well and keep the area around the pump from becoming a mud-hole	KES 100,000 per site	Contractor	Once	Completely sealed well, clean concrete pad around well
3. Socio-Economic Aspects						
Employment creation	Improved incomes and standards of living	Employment of locals	month (monthly pay bill)	Project Manager	Day – to-day	Number of employees employed
Indirect employment	Improved health from access to clean water	Promote water boiling	KES 20,000 per site for sensitization	Project Manager	Day-to-day	Number of trainings
4. Accidents, Health and Safety Plan						
Pre-drilling and drilling/ construction	Accidents from falling objects	Observation of construction standards, insurance cover for staff, protective clothing, building of perimeter ring	KES 50,000 per site	Contractor	Construction period	Receipts of purchased protective clothing, insurance policy
Operations phase	Falls, cuts and other accidents	First aid kit, clean working areas, non-obstruction;	KES 30,000 per site	Project Manager	Daily check for emergency preparedness	Number of accidents or near accidents reported

Operations	Capacity building and training	Staff training programmes for health and safety especially in emergencies	KES 50,000 per site	Project Manager	Bi-annual	Number of employees trained per year, reports from various institutions where they were trained.
	Water contamination	Water testing and maintenance of clean pad	KES 50,000 per site	Project Manager	Routine	Water test results, clean pad
	Drinking of water	Signage on water quality levels	KES 5,000 per site	Project Manager	Routine	Water test results, clean pad
5. Abandonment						
Alternative land uses	Waste lands	To be replanted with trees	KES 200,000 per site	Project Manager	Once -end of project	Replanted vegetation
Borehole	Dilapidation; accidents; ground water contamination	Piping will be removed from the borehole, as well as the pump and all the electric installations. Then it will be sealed	KES 30,000 per site	Project Manager	Once -end of project	Sealed borehole
Tank	Eyesore, obstruction	Demolition, conversion for other uses -dump.	KES 10,000 per site	Project Manager	Once -end of project	Cleared area, tank used for other uses

Table 10. 3: Framework Environmental Management Plan for Dams/Water Storage Structures

Project Activities	Potential Impact Description	Mitigation/ Enhancement Measures	Cost of Mitigation /Enhancement	Responsibility	Frequency	Verifiable Monitoring Indicators
Storm discharge and change in hydrology	Impended drainage flooding	• Ensure efficiency of drainage structures by proper design and maintenance on the dam • Proper installation of drainage structures • Visual checks on drainage channels for any leaks • Repair any blockages immediately on the spill ways and dam	200,000 per site	The proponent and contractor	Continuous	• Construction records • Inspection of all Construction works through out
Health	Rise in vector borne Disease & infection i.e. malaria	• Educate residents on use of insecticide treated mosquito nets • Disinfect the dam water regularly • Educate residents on need for regular medical check up • Supply clean disinfected water for domestic use	20,000 per site per month	Management committee in conjunction with public health officials and proponent/ local residents	Continuous – operation stage	• Disease incidence records • Water treatment records • Perimeter fence round the dam site • Reduced disease incidents

		• No watering or grazing animals near the dam • Introduce mud fish to control mosquito breeding				
Records	Legal documents storage	• Display accidents records • Keeping abstraction records	5,000 per site	Management committee	Continuous-operation stage	• Records of abstraction
Safety	Injuries and shock	• Training of community on health and safety issues near the dam site • Develop emergency exit plans and procedures • Provide clear warning signs at the site • Fencing the dam site	120,000 per site	Management committee, proponent and beneficiaries	Continuous-construction and operation stage	• Warning signs erected • Restrict entry of to the dam site training records • Perimeter fence Presence • Reported accident records
Capacity building	Environmental education	• Develop in house guidelines on the environmental, health and safety for the area residents • Educate the	35,000 per site	NEMA, Public health officials, the general public	Continuous-operation stage	• Meeting records

		residents on need for environmental conservation • Consult the local NEMA office regularly on need-basis				
The wall structures	Structural stability	• Build the structure to approved standards	1,000,000 per site	Contractor and proponent	Construction stage	• Stable structure • Certification records
Legal aspects	Non-compliance with environmental and other applicable laws	• Conduct appraisal on new legislations affecting the operations of the dam • Conduct Environmental Audits (EA) on a yearly basis	100,000 per site per year	Proponent	Construction and operations	• EIA approval letters/ licence displayed prominently
Water	Use conflicts between upstream residents and the downstream community	• Regular meeting • Provide a piped gravity supply to down wind	20,000 per site	Proponent; dam management committee; community	Continuous-operation stage	• Meetings records • Piped supply

10.10 Environmental and Social Monitoring Plan

10.10.1 General

The proposed plan for environmental and social monitoring is intended to monitor the impacts of Program interventions on critical environmental and social indicators of programme impacts. The environmental indicators include water resources (i.e. quantity and quality), soil resources (i.e. fertility, erosion, and compaction), amount of solid waste generated and conditions of nationally important wildlife sites within the project area among others. The social indicators include social cohesion (i.e. community groups/organizations), public health (i.e. incidence of water-related diseases), employment opportunities generated and improvements in livelihoods of rural households of project beneficiaries. Monitoring of these indicators will be integrated into the overall project monitoring framework.

10.10.2 Water resources

The monitoring of river flows and groundwater levels in programme areas is critical in assessing the impact of the programme activities on water resources available to project beneficiaries and competing uses. Much, if not all, of this water quantity monitoring is already being performed by MWI sub-county stations. Also critical to understanding project impacts is the monitoring of water quality indicators (e.g. mineralization, pH, turbidity, and contamination with chemicals, pesticides or pathogens) at project sites. This will require additional water sampling and laboratory analysis.

10.10.3 Soil resources

The monitoring of programme results with respect to improving soil fertility, reducing soil erosion and preventing soil compaction in the project area will be essential to assessing the project's impacts on this critical natural resource. The MoA provides extension services and monitors soil conservation in the programme area from its County and Sub-county offices and should be further encouraged to assist the program in monitoring the impacts of its interventions.

10.10.4 Forest cover

The monitoring of forest cover in project areas is critical to assessing the impact of the project in arresting and reversing the degradation of forests in the programme area. There should be a deliberate effort to work closely with Community Forest Associations (CFAs) and KFS to monitor the number of trees planted to replace those cut down during project implementation and the tree survival rate in order to evaluate the impacts of project activities on forestry resources and forest restoration.

10.10.5 Social cohesion

One of the critical outputs of the community empowerment component of the programmes is the formation and strengthening of community groups/organizations (i.e. WRUAs, CFAs etc) that will take charge of community development activities. The project committees in their role of fostering and supporting these groups/organizations will monitor their progress.

10.10.6 Public health

Activities associated with projects under the programmes may lead to contamination of water resources within the programme area through pollution by agrochemicals and pesticides. The MWI in collaboration with the MOH and project beneficiaries should monitor status of public health among local people within the programme area.

10.10.7 Livelihoods improvement

The most critical social monitoring indicator is to measure the programme results in improving the livelihoods of poor rural households. This should include increases in incomes of beneficiaries but also improvements in the quality of their lives (e.g. housing, access to potable water, sanitation, etc.) and the number of job opportunities (direct and indirect) created for the local people. The table below gives monitoring plan for indicators of programme impacts.

Table 10. 4: Monitoring Plan

Program Indicators	Parameter	Location	Method/ Equipment	Frequency	Purpose	Institutional Responsibility
Environmental monitoring:						
River/ground water quantity for programme activities and competing uses;	River flows, groundwater levels	Several sites on rivers in programme areas, water table at project sites	River gauges, groundwater wells	Monthly	Measure seasonal changes, impacts of projects	MoWI, MENR
River/ground water quality competing uses	Mineralization, pH, turbidity	Above/at/below project intakes	Field sampling equipment	Regularly before and after project	Measure quality at intake, impacts of individual projects	MoWI, MENR
Soils (fertility, erosion, compaction)	Chemicals, pesticides, pathogens	Above /at/below project intake	Sampling for MWI laboratory analysis, Field equipment for soil sampling/ analysis	Regularly before and after project	Measure quality at intake, impacts of projects and agricultural practices	MWI, MENR
	Soil salinity, humus content	Problem agricultural areas	Sampling for MWI laboratory analysis Field equipment for soil sampling/ analysis	Monthly	Measure soil fertility	MoALF, MENR
Forest cover	Erosion, compaction, number of trees planted,	Individual project sites	Visual inspection	Monthly	Gauge soil loss, damage as result of individual project	MoALF, MENR
	survival rate	Individual project sites	Visual inspection	Monthly	Measure forest restoration	CFAs, KFS MENR
Social monitoring:						
Social cohesion	Number of community groups formed and registered (WRUA, CFA)	River basins and forests of project area	Site visits, consultations	Quarterly	Determine project engagement of local communities	Project Committees
Public health	Incidence of water-related and energy use	Individual project sites	Site visits, consultations, health statistics	Quarterly	Gauge project impact on public health	MWI, Project Committees

	related diseases					
Livelihoods improvement	Incomes, quality of life (type of homes, access to potable water, etc.), number of jobs created	Programme area	Quantitative and qualitative analysis	Yearly	Gauge impact of project on livelihoods	Project committees

APPENDICES

Appendix 1: List of stakeholders consulted/engaged

Appendix 2: Evidence of stakeholder participation

Appendix 3: Records of stakeholders' participation

Appendix 4: Study methodology/work plan

Appendix 5: Consultants' Itinerary

Appendix 6: List of documentation consulted

Appendix 7: Terms of Reference for the SEA