REPUBLIC OF KENYA

TECHNOLOGY NEEDS ASSESSMENT AND TECHNOLOGY ACTION PLANS FOR CLIMATE CHANGE ADAPTATION

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Supported by:

TECHNOLOGY NEEDS ASSESSMENT AND TECHNOLOGY ACTION PLANS FOR CLIMATE CHANGE ADAPTATION

This document is an output of the Technology Needs Assessment project, funded by the Global Environment Facility (GEF) and implemented by the United Nations Environment Programme (UNEP) and the UNEP Risoe Centre (URC) in collaboration with Environmental Development Action in the Third World (ENDA Senegal) for the benefit of the participating countries. The present report is the output of a fully country-led process and the views and information contained herein is a product of the National TNA team, led by the National Environment Management Authority-Kenya (NEMA-Kenya)

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This Technology Needs Assessment (TNA) and Technology Action Plan for Climate Change Report for Adapation is an output of the Technology Needs Assessment Project under the United Nations Framework Convention for Climate Change.

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This report has assessed the technology needs for climate change adaptation in Kenya. The report has further prioritized technology needs for adaptation within the water and agriculture sectors using a multi-stakeholder process and a linear additive Multiple Criteria Analysis Framework. A Barrier Analysis and Enabling Framework for the prioritized technologies have been done and measures identified to overcome these barriers. Finally, Technology Action Plans and Project Concepts have been developed. It is my sincere hope that these 4 part report findings will prompt all stakeholders to take timely action in climate change adaptation and that the reports will form an important reference tool to spur all actors to implement the prioritized technologies in order to build the resilience of our country in a changing climate.

PROF. GEOFFREY WAHUNGU
DIRECTOR GENERAL, NEMA

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LIST OF ACRONYMS

ASALs	Arid and Semi- Arid Lands
ASDS	Agricultural Sector Development Strategy
ASDSP	Agricultural Sector Development Support Programme
CBO	Community Based Organizations
CFCs	Chloroflorocarbons
DEPR	Department of Environmental Planning and Research
EST	Environmentally Sound Technologies
FAO	Food and Agricultural Organization
GDP	Gross Domestic Product
GMOs	Genetically Modified Organisms
GOK	Government of Kenya
IPCC	Intergovernmental Panel on Climate Change
ITCZ	Inter- Tropical Convergence Zone
IW	Inception Workshop
KAM	Kenya Association of Manufacturers
KAPAP	Kenya Agricultural Productivity Project
KAPP	Kenya Agricultural Productivity Project
MCDA	Multi- Criteria Decision Analysis
MDGs	Millennium Development Goals
MEMRs	Ministry of Environment and Mineral Resources
MTPs	Medium Term Plans
MSP	Multi-Sector Process
MW&I	Ministry of Water and Irrigation
NALEP	National Agricultural and Livestock Extension Programme
NARS	National Agricultural Research Systems
NASEP	National Agricultural Sector Extension
NCC	Nairobi City Council
NCCRS	National Climate Change Response Strategy
NCST	National Council of Science and Technology
NEAP	National Environment Action Plan
NEMA	National Environment Management Authority
NGOs	Non- Governmental Organizations
NLDP	National Livestock and Diary Policy
NPSC	National Project Steering Committee
PPPs	Public Private Partnership
PSC	Project Steering Committee
PTC	Professional Training Consultants
SIDA	Swedish Development Cooperation Agency
SOE	State of the Environment Report
SRA	Strategy for Revitalizing Agriculture
SWG	Sector Working Group
TBI	Tree Based Intercropping
TNA	Technology Needs Assessment
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change

EXECUTIVE SUMMARY

Climate change is a global phenomenon that affects all countries in different ways depending on their prevailing national circumstances. Scientific evidence that climate change has potential to cause serious adverse impacts at global and local levels led to formulation of United Nations Framework Convention on Climate Change (UNFCCC) in 1992. Article 4 of the Convention outlines the major commitments of the Country Parties to respond to climate change was among others - to prepare for adaptation to the impacts of climate change and to promote and cooperate in the development and transfer of technologies, practices and processes that address greenhouse gas sources and sinks. Kenya is a developing country and is also party to the United Nations Framework Convention on Climate Change (UNFCCC) in 1992 and is committed to meeting the obligations of the convention.

The purpose of this Technology Needs Assessment (TNA) is to assist participating Developing Country Parties identify and analyze priority technology needs, which can form the basis for portfolio of Environmentally Sound Technologies (ESTs) projects and programmes to facilitate the transfer of, access to, the ESTs and know-how in the implementation of Article 4.5 of the UNFCCC.

The report starts by explaining the basis of the TNA in Kenya and describes the national institutions that were involved in the climate change policy making and implementation, and their roles in the TNA project. A description of the national physical, social and economic circumstances that form the basis for climate change adaptation are also described. The TNA process, criteria, results and selection of sectors and technologies followed a participatory approach, which included literature review, technical expertise and involvement of stakeholders through workshops, one on one consultations and structured questionnaires.

The sectors considered in the TNA were prioritized on the basis of the country's development priorities and their vulnerabilities to climate change. The processes involved review of the existing literature, involvement of stakeholders, sector working groups and technical expertise in consultation with national TNA coordination office. The same actors also influenced the criteria and decision for sector and technology identification and prioritization. The identified sectors relevant for climate change adaptation were Agriculture, Forestry and Land Use, Water Resources, Marine and Coastal Resources, Tourism and Wildlife, Human Settlements, Health and Safety were identified.

Agriculture and Water sectors were prioritized and are therefore covered in the TNA project. Water is an important natural resource and is critical for sustainable development of practically all social and economic sectors as it is required for domestic purposes, agricultural and industrial development, energy generation and livestock. Agriculture is the mainstay of the economy but since it is mainly dependent on rainfall, it is sensitive to climate change and variability.

The TNA has assessed and prioritized technology needs for adaptation for agriculture and water resources sectors. The technology options for climate change adaptation were arrived at through a process of multi-stakeholder process (MSP) and a linear additive Multiple Criteria Analysis (MCA) framework. A multi-stakeholder process (MSP) was adopted for the identification and prioritization of technology options. Three technologies were prioritized for each sector. In Agriculture drought resistant sorghum, drip irrigation and hay preservation were prioritized and in water resources sector, roof rain water harvesting, surface runoff water harvesting and solar powered desalination were prioritized as preferred technologies for adaptation.

CHAPTER 1: INTRODUCTION

Climate change is a global phenomenon that affects all countries in different ways depending on the prevailing national circumstances. Scientific evidence that climate change has potential to cause serious adverse impacts at global and local levels led to formulation of United Nations Framework Convention on Climate Change (UNFCCC) in 1992.

Article 4 of the Convention outlines the major commitments of the Country Parties to respond to climate change. During the climate negotiations it was recognized that developing countries do not have the technological, technical and financial capacity to meet their obligations under the Convention. The developed country Parties therefore, committed themselves to facilitate development and transfer of appropriate technologies and technical know-how and financial resources to enable developing countries to fulfill their commitments. Further, the Bali Plan of Action for Transfer of Environmentally Sound Technologies requires technological assessment for its implementation. It is in this context that the TNA project was formulated.

1.1 About the TNA Project

The primary goal of a TNA is to prioritize technological needs for achieving a country's development priorities in a sustainable manner. The focus is therefore to use environmentally sound technologies (EST), which address adaptation needs. The aim of adaptation to climate change is to increase the capacity of the country and communities to withstand the impacts of extreme climate events and to continue with socio-economic development with minimum interruption.

Specifically, the purpose of the TNA is to identify, analyze, evaluate, and prioritize technological needs for achieving sustainable development, increase resilience to climate change, and avoid technologies which accelerate anthropogenic climate change. If properly conceived and implemented, a TNA can achieve a number of additional desirable ends, namely contributing to enhanced capacity to acquire environmentally sustainable technologies, developing important links among stakeholders to support future investments and barrier removal, and diffusing high priority technologies throughout the sectors of national economy. Hence the purpose of this TNA is for establishing a baseline for a portfolio of programmes and projects to facilitate the transfer of and access to ESTs and knowhow in the implementation of Kenya's economic sectors.

1.2 Existing National Policies about Climate Change Adaptation and Development Priorities

The developing countries, such as Kenya, will be most vulnerable to the potential impacts of climate change because of their weak economic conditions and the already existing climate conditions. Adaptation technologies should, as much as possible, be in line with the national development plans, priorities and programmes and take into consideration the existing national circumstances.

1.2.1 National Circumstances

a) Location

Kenya is located on the East Africa Coast. It is bordered by Ethiopia and Sudan on the northern side, Somalia and Indian Ocean on the Eastern side, the United Republic of Tanzania to the South and Uganda and Lake Victoria on the western side The country lies between latitudes 3° North and 5° South and longitudes 34o and 42o East. The Equator passes through the country giving it an equatorial type of climate which is modified by altitude and human activity including climate change.

b) Population

According to 2009 census, the Kenyan population stood at 38.6 million (Kenya National Bureau of Statistics, 2010). The population distribution is uneven, from an average of 230 persons per square kilometer in high potential areas to an average of 3 persons per square kilometer in arid areas. Over 50% of the population is below 15 years.

The Kenya Constitution 2010 divided the country into 47 Counties and devolved administrative and economic activities to County and local levels.

Most Kenyans are engaged in agricultural activity as farmers, pastoralists and fishermen. Others are business people and service providers. The main socio-economic factors affecting the Kenyan population are HIV&AIDs, poverty, malaria, Tuberculosis and other respiratory diseases, and climate change.

c) Climate

Kenya's climate varies as it influenced by variable topography, ocean and inland large water bodies, high mountain ranges and the Great Rift Valley among others. The small scale air circulation patterns generated by these features interact with the large scale circulation systems mainly the Inter-Tropical Convergence Zone (ITCZ) to influence the weather/ climate patterns. The climate is also influenced by global features such as El-Nino/Southern Oscillation (ENSO) events that are controlled by the sea surface temperature fields of the Pacific Ocean, upper level wind reversals known as Quasi-Biennial Oscillation (QBO), sea surface temperature fields in the adjacent oceans such as the Indian Ocean Dipole (IOD) as well as the south west Indian ocean tropical cyclone activities. There are two main rainy seasons followed by a long dry period (MENR, 2002)). The long rains normally are in March – May while the short rains occur between October and December but the regimes are irregular and erratic and the effects of climate change are already affecting the rainfall regimes, especially in arid and semi-arid areas (NEMA, 2009).

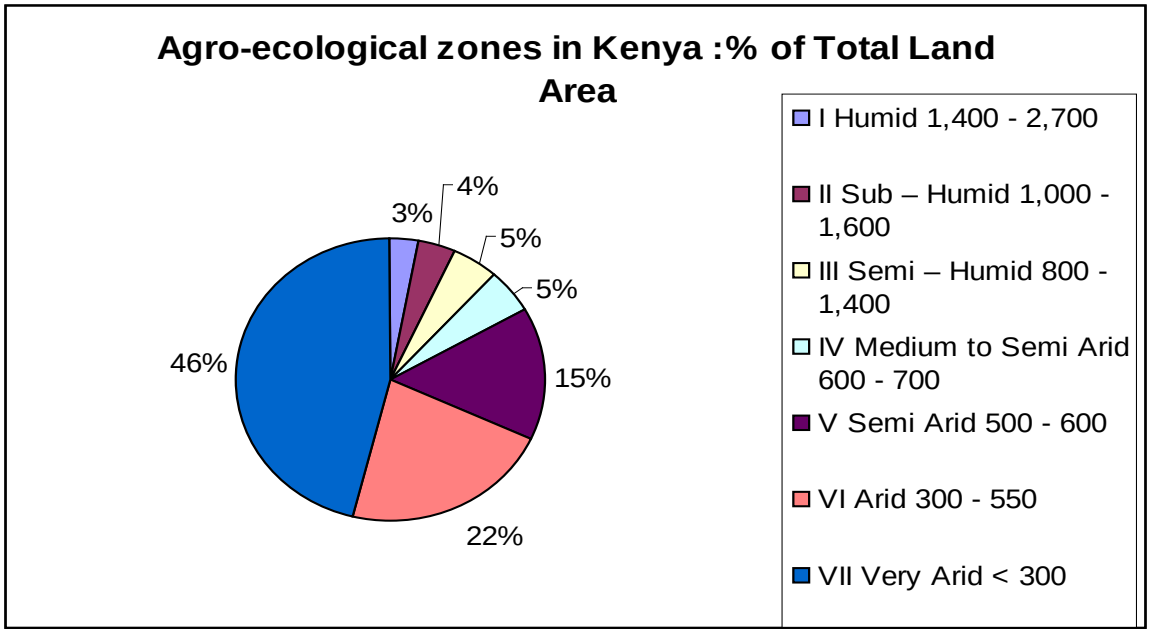
d) Ecosystems (Agro – Ecological Zones)

The country is divided into seven agro-ecological zones. These zones are determined by rainfall regime, climatic and topographical factors. These ecological zones are summarized in Figure 1.1.

Zones I to IV that cover 16% of total land area, are of high to medium agricultural potential (food crop production, cash crops and dairy farming) and supports about 80% of the country's population. The remaining 20% of the population live in zones V to VII, which comprise 84% of the total land area. These zones are mainly and semi-arid and therefore have the least potential for agriculture but are rich in wildlife, mineral resources and are therefore important for tourism development (NEMA, 2009).

These ecological zones have given rise to a variety of habitats and ecological systems making Kenya one of the Mega-Diverse Biodiversity countries of the world. Biological diversity is the basis of development including the regulation of climate and hence there is mutual beneficial relationship between economic well-being, conservation of biodiversity and adaptation to climate change (NEMA, 2009).

Figure 1.1: The Seven Agro-ecological zones as a percentage of the total land area and their yearly average rainfall in milliliters



Source: Derived from (NEMA, 2009)

e) **Economy**

Kenya's GDP at market prices is estimated at KSh 3000 Billion (KNBS, 2012). In 2011, the GDP grew by 4.4 per cent compared to 5.8 per cent in 2010, a decline which was attributed to high oil and food prices and weakening of local currency. The agricultural sector continues to dominate Kenya's economy, although only 15 percent of Kenya's total land area has sufficient fertility and rainfall to be farmed, and almost 75 percent of working Kenyans make their living on the land (World Bank, 2012). The main economic sectors which are likely to be impacted negatively by climate change and require adaptation measures include:

a) Agriculture
b) Forestry and Land Use
c) Water Resources
d) Marine and Coastal Resources
e) Tourism and Wildlife
f) Human Settlements, Health and Safety

1.3 Existing Policies about Climate Change Adaptation and Development Priorities

The current policies and development plans and strategies are anchored on Vision 2030 which is Kenya's blue print for transforming the country to a newly 'Industrialized Middle Income Country' by the year 2030 (GoK, 2007). The Vision is based on three pillars: Economic, Social and Political. All these pillars are interrelated and the fiber that bides them together is the natural environment with its inherent supply of renewable and non-renewable goods and services (UNEP 2009) climate change and environment are therefore inferred in all of pillars.

- The Political Pillar aims at realizing a democratic political system founded on issue based politics that relies on the rule of law and protect the rights and freedoms of every citizen. One important outcome from the political is the Kenya Constitution 2010. It is hailed as a green Constitution; since it embodies elaborate provisions with considerable implications for sustainable development. Chapter V is entirely dedicated to land and environment. It also embodies a host of social and economic rights of an environmental

character, such as the right to a clean and healthy environment, water, food and shelter among others.

In order to meet the obligations of Vision 2030, every Sector has developed individual plans and strategies. Examples are the National Climate Change Response Strategy (NCCRS) and the Strategy for Revitalizing Agriculture (GoK, 2010; Ministry of Agriculture 2010). NCCRS is the first document in Kenya dedicated to addressing the threats posed by climate change, and it emphasizes the vulnerability of the Kenya economy to climate change. The Strategy also notes that climate change is considered one of the most serious threats to sustainable development globally and nationally.

The NCCRS primary focus is ensuring that adaptation measures are integrated in all government plans and development objectives. This requires collaborative and joint action with all stakeholders including the private sector, civil society, Non-Governmental Organizations (NGOs), and Community Based Organizations (CBOs) in tackling the impacts of climate change.

Policy directions, legislation as well as adaptation measures in various sectors are also outlined. The need for technology development, transfer and utilization is also evident as a major action for alleviating the impacts of climate change. Measures required to reduce the negative impacts of Climate Change and to take advantage of its positive impacts have been incorporated in the strategies. Some of the recommended adaptation measures in various sectors are outlined in Table 1.1.

The impacts of climate change are linked with the achievement of key national development objectives and the Millenniums Development Goals (MDGs) including poverty, food insecurity, health threats, environmental degradation and loss of natural resources and thus MDGs objectives will be constrained by climate change impacts unless the capacity to adapt is strengthened (UNEP, 2009).

Table 1.2: Selected NCCRS recommended adaptation measures by sector (GoK, 2010)

	Sector	Recommended Adaptation Measures
1.	**Agriculture and Livestock**	• Enhance technical and financial support to the orphan crops eg cassava and sorghum • Promoting irrigated agriculture by developing irrigation schemes, construction of water basins and pans • Invest in programmes to harvest and store fodder for use during dry season. Promotion of efficient water use systems and use of marginal quality water
2.	**Water**	• Increasing capture and retention of rain water through the construction of water ways, strategic bore holes and other water harvesting methods • Desilting rivers and dams to improve carrying capacity, water storage and water quality • structures to ensure availability of water during the dry season • Protection of water towers
3.	**Health**	• Improving access to clean water and sanitary facilities to limit outbreaks of water borne diseases such as cholera and typhoid • Scaling up programmes such as the "Roll Back Malaria" in response to the expected increases and incidences of malaria outbreaks • Setting up vaccination and immunization Programmes against diseases whose occurrences will be acerbated by climate change and climate variability
	Sector	**Recommended Adaptation Measures**
4.	**Fisheries**	• Providing economic incentives to diversify livelihoods options to reduce dependence on climate-sensitive marine resources • Implementing adaptive management of fishing capacity based on climate and environmental forecasts to protect against extreme events
5.	**Tourism and Wildlife**	• Creating community wildlife conservancies to help in the conservation of wildlife especially of endangered species • Improving wildlife species conservation efforts through wildlife translocation during extreme droughts
6.	**Human Settlements**	• Constructing dams and dykes in flood prone areas and improving knowledge and skills in disaster preparedness and management • Establishing insurance schemes to make reparations in regions affected by climatic disasters. • Proper planning of urban settlements taking into consideration the expected high growth rates of urban population due to climate induced migration form rural areas to urban centers.

CHAPTER 2: INSTITUTIONAL ARRANGEMENT FOR THE TNA AND STAKEHOLDERS INVOLVEMENT

2.1 National TNA Team

The TNA process is a national process involving various ministries, NGOs and private sector.

2.1.1 National Coordination

The National Environment Management Authority (NEMA) within the Ministry of Environment and Mineral Resources (MEMR) which is the government technical institution on issues of environment and focal point for UNFCCC was identified to coordinate the development of TNA in Kenya. Within NEMA the project is anchored at the Department of Environmental Planning and Research (DEPR) and the National Climate Change Focal Point was designated as the coordinator for the TNA process in order to ensure that objectives of the TNA process are met. A National Project Management Unit (PMU) comprising of all NEMA departments, Kenya Association of Manufacturers (KAM) and National Council of Science and Technology (NCST) was established for project coordination. A list of PMU representatives is given in Annex 2.1.

2.1.2 National Project Steering Committee (NPSC)

The National Project Steering Committee (NPSC) was established as an apex organ to give policy direction to the process. It is composed of key departments and institutions involved in Climate Change related activities and include the Ministries of Energy, Local Government, Finance, Environment and Mineral Resources, Forestry and Wildlife, Agriculture, Water and Irrigation and Public Health; National Council of Science and Technology (NCST) and representatives from private and civil society organizations. A list of NPSC representative is given in Annex 2.2

2.1.3 The TNA (Adaptation) Consultants

The NPSC using government tendering system identified a consultant (Professional Training Consultants – PTC) to provide technical input to the TNA process. List of Consultants for Adaptation is attached as Annex 2.3. The Consultant and the National Coordinator underwent two training sessions together with other participants from participating countries on the TNA process.

2.1.4 Key Stakeholders

Following in-depth literature review PTC, in consultation the Client (NEMA), undertook a detailed stakeholder identification and analysis including their roles in the TNA process. Detailed analysis was necessary to enable the TNA process to be undertaken in participatory and consultative process in order to incorporate the views and interests of the major stakeholders in climate change adaptation in the country. Stakeholders are central to the TNA process because they will be intimately involved not only in the process itself but also in the implementation of the resulting technologies. For the purpose of this study, stakeholders are institutions that are in one way or another involved, or have interests, in climate change technology development, promotion, transfer or application as well as individuals who have taken keen interest in climate change related activities. The stakeholders are grouped into ten categories and were based on the roles they play in the climate change adaptation agenda in the country. These are:

a) Government Institutions
b) Private and Public Industries, Associations and Distributors
c) Technology Development Suppliers
d) The Finance and Investment Community
e) Technology End Users
f) Non- Governmental Organizations
g) Support Institutions
h) Awareness Creation Institutions

i) International organization participating in Climate Change Adaptation Programmes

A detailed list of institutions identified under each category is shown in Annex 2.4.

2.1.5 Adaptation Sector Working Group

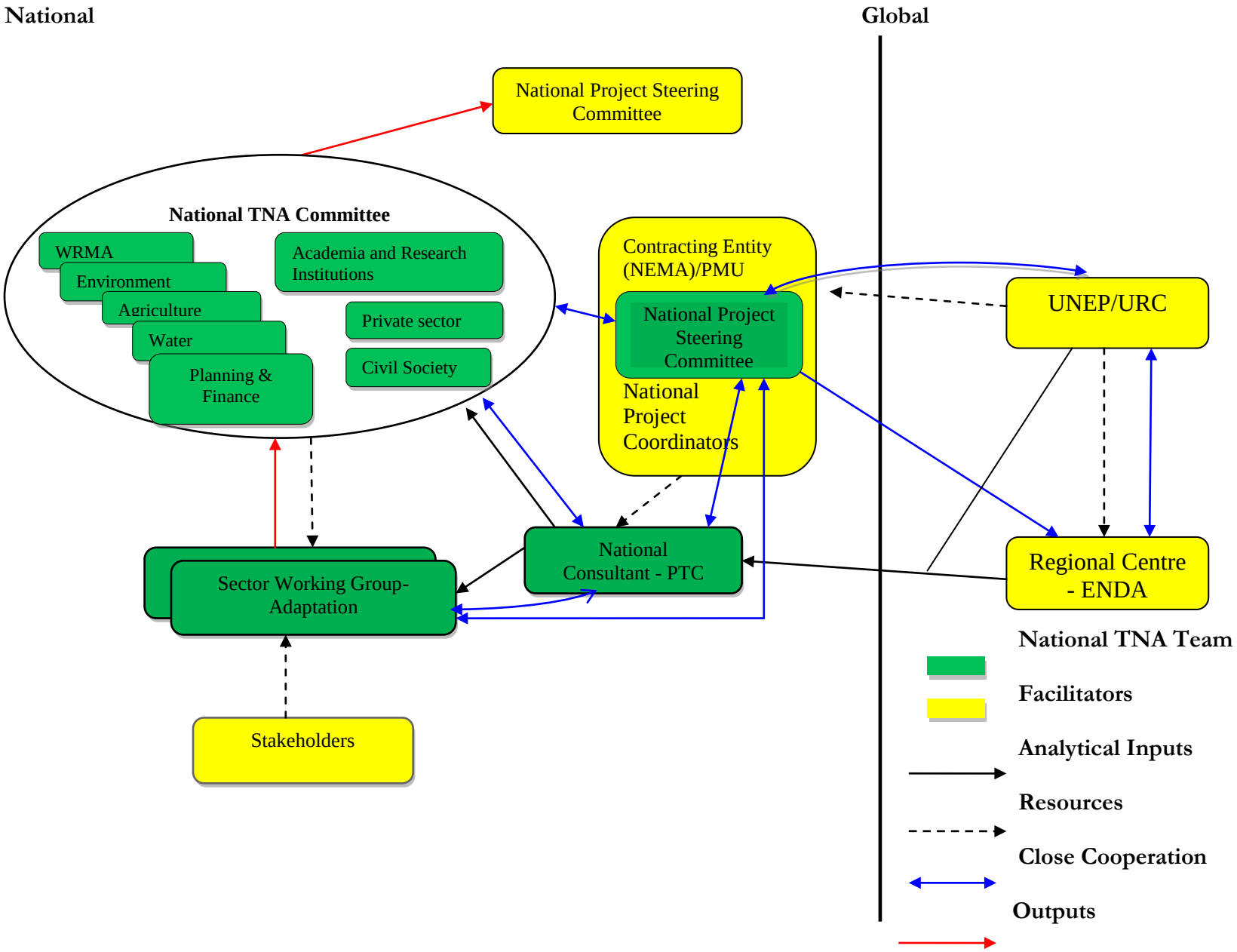
The stakeholder analysis report was presented and enriched at the inception workshop. The analysis guided the formation of the key stakeholders for validation and consensus reaching for the TNA process. The key stakeholders were consulted through one to one basis to identify institutions involved in climate change adaptation. Following consultations with the Client and the key stakeholders a Sector Working Group on Adaptation was formed (Annex 2.5)

Table 2.1 below summarizes the main international and national institutions involved, and their roles, in the process and in Figure 2.1 the institutional structure and interaction between different institutions/players, during the process is given.

Table 2.1: TNA institutional arrangement and functions

ORGANIZATION STRUCTURE	COMPOSITION	MAIN FUNCTIONS
UNEP	GEF Section	• GEF implementing agency for the TNA project
UNEP RISOE	Department Dealing With Climate Change Strategies and Resilient Development	• Overall project management, liaison with UNEP and ENDA:
ENDA –Regional Body	Energy – Team dealing in energy and climate change (climate vulnerability and adaptation)	• Technical support to African participating countries, including Help Desk.
National Project Steering Committee (NPSC)	Key Climate Change Institutions e.g. Ministries of Energy, Local Government, Finance, E&MR, Forestry and Wildlife, Agriculture, Water, Public Health, NCST and representatives from private and civil society	• Policy & Supervisory roles and approvals of TNA Outputs • Political Acceptance for the TNA
NEMA – National Coordinating Institution	DEPR - Climate Change Desk Officer (Designated National Project Coordinator)	• National Focal Point for the TNA process • Overall Coordination Link between UNEP RISOE, ENDA and Consultants • Link between NPSC, Consultants and key stakeholders • Administration & day to day running of Project
Project Management Unit	The DEPR at NEMA in collaboration with all other NEMA Departments, line ministries, representatives from private sector	• To coordinate with and support the national consultants to ensure that all the objectives of the TNA project are met and project is successfully completed
Consultants	PTC Consultants	• Technical Input in close consultation with PMU and SWGs • Provide initial drafts for discussion and approvals
Sector Working Group (SWG) - Adaptation	Experts in climate change adaptation from public, private sector, research and civil society institutions	• Technical input including sector prioritization, technology identification, process and quality control of outputs. • identification of barrier analysis and enabling environment
Main stakeholders	Representatives from Key Institutions from public, private sector, NGOs and civil society working on issues of climate related activities	• Validation of Project Outputs and Consensus Building

Figure 2.1: Institutional Structure of the TNA Project (Adopted from Dhar et al, 2010)



2.2 Stakeholder Engagement Process followed in TNA – Overall Assessment

The stakeholder engagement process followed during the TNA processes is as follows:

a) Through workshops and working sessions

These included the inception workshop where the stakeholders were introduced to TNA process and inception report by the consultants, which was initially discussed with the Project Management Unit, was presented, discussed and endorsed. During the workshop, broad sectoral working groups were formed namely, Agriculture, Livestock and Fisheries, Water Resources and Coastal marine ecosystems, Human settlements, Health and Safety, and Forestry, wildlife and tourism. Each working groups identified the key sectors involved in adaptation and also identified initial relevant technologies per sector.

Two other workshops were held to engage the stakeholders in the selection and prioritization of adaptation sectors and technologies for climate change adaptation. A Sector Working Group was also formed. List of participants for the different workshops is given in Annex 2.6.

b) Through one to one engagement

The consultants, through NEMA, continually engaged different stakeholders to obtain the necessary information and build consensus on the process. A questionnaire, prepared by the consultants in consultation with NEMA, was also administered to the stakeholders to collect views on priority sectors and proposals on adaptation technologies. A sample questionnaire is presented in Annex 2.7 and a list of stakeholders who completed the questionnaire is presented in Annex 2.8.

c) Involvement of sector working group

The adaptation sectors were consulted and involved at all stages for technical input during sector prioritization, technology identification, process and quality control of outputs. The contribution of the sector working groups is presented in subsequent chapters.

CHAPTER 3: SECTOR PRIORITIZATION

The sector prioritization processes was guided by the contribution of the sector to national economy and its vulnerability to climate change. The analysis of sectors showed that there was significant impact and detrimental socio-economic impacts of climate change and extreme events on agriculture, water resources, forestry and land use, marine and coastal resources and human settlements, health and safety.

3.1 An Overview of Expected Climate Change and Impacts and Sectors Vulnerable to Climate Change

3.1.1 Agriculture Sector

Agriculture continues to remain a significant sector of Kenya and plays a leading role towards the national economy. The sector comprises crop production, livestock and fisheries. The country's agriculture is mostly characterized by subsistence farming which is operated by small holder farmers using relatively low farm inputs. Agriculture production is predominantly rain-fed with irrigation accounting for only 1.7% of the total land under agriculture (GOK, 2007). Crop production and productivity are generally low and average yield of major rain-fed crops grown in the country is about 1.0 tons per hectare due to a number of factors including low crop husbandry practices with resultant low production levels.

Livestock production is the dominant activity in the Arid and Semi-Arid Areas of Kenya (ASALs) (SOE 2003). Although ASALs have enormous livestock development potential, development in these areas has been low compared to other areas due to shortage of pasture, water and inadequate livestock extension services (GoK 2010). The key livestock types in Kenya are beef and dairy cattle, camels, pigs, sheep and goats.

In addition, the country is endowed with natural resources that can be used for fisheries and bee keeping. Kenya is well endowed with fish resources and according to NCCRS, 2010, the inland lakes, coastal and marine ecosystems are repository of rich natural resources which support local and national economies including fisheries, terrestrial forests, mangroves, sea grass beds and coral reefs. These ecosystems are however, threatened by resource exploitation, degradation of habitat, pollution and climate change.

3.1.1.1 Contribution of Agriculture Sector to National Economy

Agriculture is the mainstay of the Kenyan economy and account for about 26% of GDP directly and another 25% indirectly through linkages with manufacture, distribution and other service related sector (GoK, 2010). Agriculture is the means of livelihood of most of our rural population with an estimate of about 80% of the population deriving their livelihood from agricultural activities (SoE, 2004). Agricultural sector grew at an average of annual rate of 3.5% in the 1980s but declined to 1.3% in 1990s (GoK 2010).

It is estimated that 89% of the land mass in Kenya is used for agriculture and livestock. About 12% of the surface of Kenya is regarded as high potential agricultural land, while 8% is of medium agricultural potential and the rest as Arid and Semi Arid Lands (ASALs). The sector contributes towards food, security and poverty reduction through production of maize, other cereals, livestock and livestock products including fisheries. (GoK, 2007)

Livestock contributes 7% of the national GDP and accounts for 30% of the farm gate value of agricultural commodities. The livestock sector employs and accounts for 50% of the agricultural labour force with 80% of Kenya's land area being ASAL where livestock production is best suited, livestock remains one of the sectors with the highest potential to contribute to poverty alleviation.

3.1.1.2 Impact of Climate Change on Agriculture

Agriculture is generally the first economic sector to be affected by climate extremes through drought and floods, due to its reliance on rainfall. The unpredictability of Kenya's year to year productivity causes substantial problems for poor subsistence farmers as the rain fed crops are lost during unusually dry or wet seasons.

The drought which occurred between 2008 and 2011, serves to highlight some of the devastating and pervasive socio– economic consequences resulting from weather events. The greatest impact of drought in agriculture sector are crop production losses arising from reduced yields of food crops and cash crops which according to GoK (2012) amounted to Kshs 69 billion and Kshs 52 billion respectively

Livestock in the semi-arid parts of Kenya has in the past been greatly affected by changes in climate, manifested through frequent, intense and long lasting droughts. In 1991/92 drought, pastoralists lost up-to 70% of their livestock herds and in 2009 pastoralists lost over 50% of their herds to droughts (SOE, 2007). Fish in the major lakes in Kenya has not been spared by changes in climate, which has tremendously contributed to water pollution and subsequent reduction of fish landings (SOE, 2007).

Rainy seasons in Kenya can be extremely wet and often late or sudden, bringing floods and inundation, such as in 2000 (GoK, 2012). Major floods periodically afflict the Winam Gulf of the Lake Victoria, the Lower Tana basin and the coastal regions. Geographically, the western, northern, eastern, central and south-eastern parts of the country are quite susceptible to seasonal floods in the wet seasons of March to May and October- November- December. Riverine floods are the most dominant floods in Kenya, although the ASALs are particularly vulnerable to flash flooding.

Flood events have the potential to cause devastating consequences in agriculture. Floods directly impact agricultural production by inundating land and flooding of storage facilities, leading to the destruction of crops and harvested food that has been stored. Floods, together with higher temperatures, are also having indirect impacts, such as expansion of some crop pathogens

Large numbers of livestock are directly lost in floodwaters, for example, the El Nino flood of 1997/98 which resulted in livestock losses of over 90% in several regions of the country (KPACJA, 2009). There are also significant livestock health risks associated with flooding, for instance, following the same El Nino flood event, outbreaks of bovine disease were responsible for 80% reduction of livestock in northern Kenya. (GoK 2012).

3.1.1.3 Activities in the Agriculture Sector related to Climate Change Adaptation and Relevant Policies and Programmes

Agriculture is a key sector for tackling hunger, and reducing poverty in a country like Kenya. As agriculture is directly affected by climate change, adaptation strategies, technologies and practices are becoming increasingly important issues for promoting development.

The Vision 2030 (GoK 2007) aimed at transforming Kenya into a "newly- industrialized, middle income country providing a high quality of life to all its citizens in a clean and secure environment". Agriculture sector is identified as one of the key sectors of the economic pillar in the Vision 2030 and envisions an annual growth rate of 5-7%.

The strategies and activities in the Agriculture Sector related to climate change adaptation include:-

a) Crop Production

Use of different crops or varieties to match changing water supply and temperature conditions; change farming practices to conserve soil moisture and nutrients; reduce run off and control soil erosion; change land surface to reduce run off and improve water uptake and reduce wind erosion; exploring the use of seasonal forecasts; combating drought through improved crop varieties; land management and conservation; agroforestry; forestry; promote small scale irrigation; investing in pest and diseases control; high tech plant breeding; flood tolerant crops; dryland farming practices; early maturing varieties; conservation agriculture and micro-dosing.

b) Under Livestock Production

Participatory breeding involving local breeds; establishment of fodder banks; replanting range lands; and diversification of dairy products.

c) Under Fisheries and Aquaculture

Learning indigenous knowledge from the communities; diversifying livelihoods with aquaculture and salt-tolerant tilapia breeding. There are several National Development Policies relating to agricultural reform Programs and Projects in the Agriculture Sector such as The National Agriculture and Livestock Extension Program (NALEP); Strategy for Revitalizing Agriculture (SRA) 2004 – 2014; Agricultural Sector Development Strategy (ASDS)2010 – 2020; National Agricultural Sector Extension Services Policy (NASEP); Kenya Agricultural Productivity Project (KAPP) now called Kenya Agricultural Productivity and Agribusiness Project (KAPAP).

3.1.1.4 Opportunities for Adaptation Technologies in the Agriculture Sector

There are opportunities for climate change adaptation technologies in the Agriculture Sector that have been prioritized and could be implemented. Some of these include the following: introduction of drought tolerant sorghum, Drip Irrigation, Conservation Tillage, Biotechnology – Tissue Culture Banana, Early Warming Systems for Crop Production and Hay Preservation.

Upon prioritization two technologies were selected and they include: Introduction of Drought Tolerant Sorghum and Drip Irrigation. The other area of opportunity relates to reforms in agricultural related legislations where over 131 statutes are being consolidated into about 5 Bills under Agriculture covering such sub-sectors as Agriculture, Livestock and Fisheries Development.

3.1.2 Water Resources Sector

Water is an important natural resource and is critical for sustainable development of practically all social and economic sectors as it is required for domestic purposes, agricultural and industrial development, energy generation and livestock and tourism development. It is however vulnerable to the increasing rainfall variability and the growing population and associated increased demand and pollution.

The country's water endowment is low and the demand for renewable freshwater outstrips supply, with only 57% of households using water from sources considered safe (MW & I, 2010). The annual per capita availability of renewable freshwater is only 647 cubic meters (m^3), far much lower than the UN recommended amount of 1000 m^3, implying that Kenya can be classified as a water scarce country. The volume of annual renewable surface water is about 19.7 x 10^9 cubic meters per year (m^3/yr) whereas that of the renewable groundwater is estimated to be 2.1 x 10^9 m^3/yr (MW&I, 2010).

Surface water resources in Kenya are found within the five drainage basins namely, Lake Victoria, Rift Valley, Athi River, Tana River and Ewaso Nyiro. Among the drainage basins only Tana and Lake Victoria can be classified as having surplus water while the rest have water deficit (National Water Master Plan, 1999). The distribution of water availability is dependent on rainfall patterns in the country, which varies from 0 to about 250 mm in the Arid and Semi arid areas (ASAL) such as Garissa, Isiolo, Mandera, Marsabit, Moyale, Turkana, among others; to 2,000 mm in high potential areas such as Nyeri, Meru, Nyandarua, Mt. Elgon regions, among others. There can be large seasonal variation in rainfall such that during the long dry season, water shortage is experienced in many river basins, while during the rainy season severe floods cause tremendous damage in the same river basins (NEMA, 2008).

3.1.2.1 Contribution of Water Resources Sector to National Economy

The Kenya Government policy, including the Vision 2030, recognizes water as the key to all the anticipated economic and social developments (GOK, 2007). Agriculture, the mainstay of Kenya's economy, is the main user of water and currently consumes about 80 per cent while domestic and commercial use accounts for the rest. Additionally, Kenya is highly dependent on hydro-electricity, which is dependent on water from various rivers (GOK, 2010; MW&I, 2010). Hydro-power constitutes around 75 per cent of the total electricity generated in Kenya (MW&I, 2010). The aquatic resources, both freshwater and marine, also contribute significantly to the local and national economies through fishery and as tourism attraction sites.

There is a strong link between poverty and lack of access to improved water supply and sanitation and diminishing water resources. Adequate quantity and quality of water is a basic requirement for Kenya's economic growth and performance. The main constraint to development, income generation and food security in the ASAL areas is inadequate water (MW&I, 2010). However, and despite the fact that Kenya's socio-economic development goals are highly dependent on availability of good quality and quantity water, water is becoming increasingly scarce mainly due to a limited national endowment, the growing needs of rapidly increasing population, as well as serious water resources degradation (MW&I, 2010). In addition to this scarcity, Kenya is highly vulnerable to rainfall variability: droughts are now endemic and floods occur quite frequently.

3.1.2.2 Impact of Climate Change on Water Resources

According to NEMA (2008), climate change projections show that rainfall patterns in the country will change, with a few areas having increased mean annual rainfall whereas most of the country will experience lower mean annual rainfall. The cumulative effects of climate change will likely lead to increased occurrence of extreme climatic episodes of droughts and floods on varying spatial and temporal scales.

Warming associated with climate change accelerates the rate of surface drying, leaving less water moving in near-surface layers of soil, which lead to reduced downward movement of water and so less replenishment of groundwater supplies. In locations where both precipitation and soil moisture decrease, land surface drying is magnified, and areas are left increasingly susceptible to reduced water supplies (MW&I, 2010).

Climate change will also affect water quality (NEMA, 2008). Increase in water temperature result in water degradation as it leads to a bloom of microbial populations, which can have a negative impact on human health. Additionally, the rise in water temperature will lead to migration of diseases vectors like mosquitoes to areas not infested. Similarly, a decline in water quality can result from the increase in precipitation since the associated increased runoff will carry higher levels of nutrients, pathogens and other pollutants, leading to significant health implications. Along the coastal zone water quality is likely to be affected by the projected rise in sea levels,

which will increase salt concentrations in groundwater and estuaries through intrusion of the sea water.

Groundwater resources are less sensitive to climate variability than the surface water and research indicates that ground water resources may be less vulnerable, except in ASAL and coastal areas, to the impacts of climate change. In the ASAL areas, however, where the groundwater recharge may be negatively affected by climate change and in coast areas where sea level rise could result in salt intrusion great care should be exercised in exploitation of groundwater. It is generally anticipated that the impact of climate change on the groundwater resources will be more gradual than in the case of surface water resources (NEMA, 2006).

3.1.2.3 Activities in the Water Sector Related to Climate Change Adaptation and Relevant Policies and Programmes

The activities in the water sector related to climate change adaptation include water sector reforms whose main objective is to enhance management of the resource and deliver of quality services to the citizens, groundwater abstraction, rainwater harvesting and building of water storage capacity (GoK, 2007; MW&I, 2010).

The Water Act of 2002 (GoK, 2002) provided a legal framework that guided the creation of institutions to manage water resources. This is through the formation of a Water Resources Management Authority, responsible for water pollution, and the management of lakes, aquifers, and rivers, and the establishment of a Water Services Regulatory Board, responsible for water supply through licensed water services providers.

The Vision 2030 (GoK, 2007) recognizes water as the key to all the anticipated economic and social developments and therefore calls for conservation of water resources and development of new ways of harvesting and using rain and groundwater. In line with Vision 2030, the Ministry of Water and Irrigation has developed a National Water Harvesting and Storage Management Policy (MW&I, 2010) whose main objective is to provide a framework for expansion of infrastructure for national water storage capacity from the current 124 Mm^3 to 4.5 Bm^3 in order to ensure an increase in per capita storage from 5.3m^3 to 16m^3 over the next ten years. The policy also envisions development of elaborate underground water re-charge systems based on harvesting of at least 15% of surface runoff in farms and along the road networks.

3.1.2.4 Opportunities for Adaptation Technologies in the Water Resources Sector

Opportunities for adaptation technologies in the water resources sector include groundwater abstraction, rainwater harvesting, development and implementation of policies and regulations to encouraging water resources management and water conservation practices (MW&I, 2008, 2010). The other opportunity is development of water desalination technology in order to make use of the country's seawater endowment and adapt to climate change induced sea water intrusion of groundwater along the coastal region (NEMA, 2005).

3.1.3 Forestry and Land-use Sector

Kenya's forests cover stood at about 12% of the country's land surface area at independence in 1963 but now stands below 2% (NEMA, 2004). The drastic reduction in forest cover has been attributed to conversion of forests to other land uses including agricultural production, human settlement and infrastructure development. Lesser drivers of deforestation include illegal logging, wildfires and natural disasters such as droughts and pests and diseases.

In order to restore the country's forest cover to the internationally recognized benchmark of 10%, the country has put in place long and medium term plans. In the long-term timeframe, Kenya's Vision 2030 (GoK, 2007), the country's long-term development blue print aims at

attaining at least 10% forest cover by 2030. This will be accomplished through intensification of tree growing and management in farmlands and drylands, restoration of degrade forests in the main water towers as well as involvement of communities in the management of public forests. In the medium term timeframe, the First Medium Term Plan, 2008-2012 aims to increase the forest cover to 4% by planting 4.1.million hectares of new forests during the plan period.

3.1.3.1 Contribution of the Forestry and Land-use Sector to the National Economic Development

Although Kenya's forest cover is less than 2% of the country's land surface area, forests contribute immensely to the national economy through provision of wood and non-wood products for commercial and domestic use, and environmental services for sustenance of humans and other forms of life.

Wood remains the major forest product traded in the market. Before the ban on harvesting in 2000, Kenya's forests produced a total of 1 million cubic meters of round wood to sustain the country's wood based industries (Kagombe et al. 2005). Wood fuel is the other forest product of significant importance in the market. It is estimated that 75% of Kenyans use wood fuel either as firewood or charcoal as source of energy with a combined annual consumption of 15.3 million tons (FAO 2005). Transmission and construction poles are the other wood product of importance in the market.

The 2005 Economic Review (GoK, 2005) estimates the forestry sectors' contribution to the GDP as 1.1 per cent, which translates to 16.4 billion Kenya Shillings. It is estimated that the sector employs over 50,000 people directly and another 300,000 indirectly (KFS 2009). In addition an estimated 1 million households living 5 kilometers from forest reserves depend on forests for grazing, herbal medicine and non-wood products.

3.1.3.2 Impact of Climate Change on Forest Development

Climate change and forests are intrinsically related: on one hand, climate change stresses forests through its effects on mean and annual temperatures, frequent and prolonged droughts and frequent extreme weather events, and on the other hand forests and the wood they produce sequester and store carbon, a major greenhouse gas, thus mitigating climate change.

Forests thrive in a variety of climatic conditions ranging from wet montane forests to dryland forests. However, they generally flourish best in warm and wet environments and do progressively less well as moisture and temperature decrease. Climate change, in particular lead to increased temperatures and changes in rainfall and can therefore have significant impact on forests. In Kenya, climate change is expected to affect the regeneration capacity, growth and composition of forests leading to reduced biodiversity, as well as reduced capacity of the forests to deliver important forests goods and services. Depending on the extent of the climate variability, these impacts could lead to deforestation, land degradation and desertification.

Prolonged and frequent droughts are expected to lead to frequent and severe forest fires and changes in vegetation types and species composition as the result of the existing forest types giving way to new ones that are more suited to the new climatic conditions. This will be more pronounced in arid and semi-arid areas where invasive species are expected to replace the endemic ones.

3.1.3.3 Activities in the Forestry and Land Use sub-sector related to Climate Change Adaptation and Relevant Policies

The National Climate Change Response Strategy (GOK 2010) identified the Forestry and Land Use sector as one of the sectors to spearhead national efforts to adapt to climate change. Among the activities identified in the strategy are:

i) Increased afforestation and reforestation targeting:
   - Rehabilitation of degraded forests
   - Establishment of farm forestry woodlots
   - Promotion of growth of drought tolerant and pest resistant tree species
   - Restoration of mangrove forests

   It is intended to raise an average of 300 million seedlings annually over the next 20 years to plant trees on 0.2 million hectares of land.

ii) Promotion of agroforestry to enable rural household to meet their subsistence and energy needs

iii) Promoting alternative livelihood systems such as beekeeping, silk worm rearing and farming of gums and resins.

iv) Improving timber yields by planting mixtures of species and maintain several age classes

v) Reducing frequency of fire outbreaks through intensified forest fire management practices

3.1.3.4 Opportunities for Adaptation Technologies in Climate Change in the Forest and Land Use Sub-sector

In the forestry and land use sub-sector climate change is expected to impact on both existing and newly established stands in various ways. Both temperature and the amount of rainfall are crucial to forest growth. In general, warmer and wetter climate will enhance forest growth while warmer and drier climate will be detrimental to tree growth resulting in high tree mortality, which in turn will lead to forest degradation. Climate change adaptation will require the use of good forestry practice in order to enable the forests to adapt to climate change naturally through natural regeneration and tree migration but could also be facilitated by human intervention through replanting disturbed forests with species of varieties that are more suitable to the changed climatic conditions. Failed or disturbed forest plantations can be regenerated with fast growing and drought tolerant species chosen for their adaptability as well as their timber production values. Other adaptation strategies include shortening of crop rotations and relocation of plantations to areas with suitable climatic conditions.

An increased rise in temperature could extend the ecosystem range of pests and pathogens leading to severe outbreak of forest diseases and pests. This is likely to affect many aspects of forestry including tree growth, yield and quality of wood and non-wood products. In the short-term, forests or trees damaged by diseases or pests can be harvested and the usable wood commercially utilized. Adaptation through harvesting of damaged forests and replanting with improved varieties can substantially reduce loses that would otherwise occur if natural forests were allowed to regenerate on their own. Risks of pest outbreaks can further be reduced by attaining a mixture of species and ages in mixed forests instead of monoculture stands.

Substantial rise in temperatures coupled with long periods of prolonged drought will lead to more frequent and intense forest fires. Forest fires have in the recent past affected Kenya's forests leading to huge loses of both natural forests and forest plantations. Forest fire outbreaks risks can be reduced by through integrating forest fire management into the overall forest management plans. Forest fire management activities could include reduction of fire fuels loads and undertaking awareness creation among forest adjacent communities.

3.1.4 Marine and Coastal Resources Sector

Kenya is endowed with a 600 mile Coastline which has diverse habitats such as mangrove forests, coral reefs, sea grass beds, rocky and sandy beaches and muddy areas and deltas. These areas are rich in biodiversity and the coastal strip is also used for Agriculture and other development activities. The ocean is also an important heritage for Kenya and is rich in biodiversity and mineral exploration might reveal mineral wealth including petroleum products.

3.1.4.1 Contribution of the Marine and Coastal Resources Sector to National Economic Development

The aquatic resources, coastal and marine resources are a major contributor to Kenya's economic well being. The coastal and marine environment is important for tourism, ocean transport and fishing. Tourism is the 2nd largest foreign exchange earner in Kenya and the aquatic resources contribute greatly to this sector through marine parks tourism, bird watching, sandy beaches and coral reef exploration. The port of Mombasa is the gate way to Kenya, Uganda, Rwanda Burundi, Democratic Republic of Congo and Southern Sudan to name a few benefiting countries.

3.1.4.2 Impact of Climate Change on Marine and Coastal Resources Sector

Marine and coastal resources are particularly vulnerable to projected changes in the Earth's climate. Increases in ocean and air temperature, the acidification of the oceans, rising sea levels, and shifts in ocean circulation are some of the key physical changes that will stress marine and coastal environments. Among the significant ecological impacts are coral bleaching, species invasion, changes in species distribution and biodiversity, and reduced biological productivity.

Sea level rise is likely to lead to inundation of low laying areas with consequent human habitat and economic loss. It is also likely to result in intrusion of saltwater into groundwater aquifers leading to water stress in the coastal areas.

3.1.4.3 Activities in the Marine and Coastal Resources Sector Related to Climate Change Adaptation and Relevant Policies and Programmes

The main activities in this sector are associated with wildlife, Tourism, Energy, Environment and Agriculture. All these sectors are undergoing reforms in order to align themselves to Vision 2030. According to Vision 2030 (GOK 2007), tourism at the coastal region should be expanded and improved. This will entail developing new hotels, increasing the bed capacity of exiting hotels and improving the quality of services. In addition the infrastructure should also be expanded and increased. These include airports, sea ports, roads and railway to enhance communication within and outside the republic.

The coastal region is also earmarked for the Development of new irrigations schemes and improvement of the existing ones. In recent times, the coastal zone has been experiencing mineral and oil exploration e.g. titanium mining and deep sea petroleum exploration and exploitation. Other activities include the conservation and management at the Tana Delta, where aquaculture for export of sea foods is proposed. Plans are also underway to expand the marine fisheries at both the near-shore and offshore.

3.1.4.4 Opportunities for Adaptation Technologies in the Marine and Coastal Resources Sector

The existing opportunities for adaptation technologies in the marine and coastal resources sector in Kenya include disaster preparedness, building of coastal dykes and seawater desalination.

3.1.5 Human Settlements, Health and Safety Sector

In Kenya human settlements can be divided broadly into urban and rural settlements but the two are interactive. The country is largely a rural society with most of its people living in dispersed

rural settlements and their key source of livelihood being agriculture (crop and animal husbandry). Most rural people provide their own forms of shelter using locally available materials from biomass, soil and stones. With increased of population, urbanization has led to increased pressure on natural resources. Land use conflicts manifest themselves in urban expansion into prime agricultural zones and encroachment into environmentally fragile lands including indigenous forests, aquatic and wetland systems (NEMA, 2003).

3.1.5.1 Contribution of the Human Settlements, Health and Safety Sector to National Economic Development

Urban settlements play a vital role in social and economic development in all countries. They build diversified and dynamic economies which raise productivity, create jobs and wealth, provide essential services, absorb population growth and become the key engines of economic and social advancement (UNCHS-Habitat/UNEP 1997). Thus, efficient and productive cities and towns are essential for national economic growth and welfare.

According to (UNCHS-Habitat/UNEP (1997), development potential of cities is increasingly threatened by environmental degradation. Apart from its obvious effects on human health and well-being, environmental degradation directly impedes socio-economic development. Water, air and soil pollution, for example, impose extra costs on business industry, and on households as well as public services.

Human settlements lead to potential environmental degradation from sourcing of construction materials and clearing of ecosystems such as forests, wetlands, arid and semi-arid areas which are turned into settlements farmlands or pasture. Clearing and removal of vegetation leads to environmental degradation and exacerbates climate change.

3.1.5.2 Impact of Climate Change on Human Settlements, Health and Safety Sector to Climate Change

Climate plays an important role in people's livelihoods as it determines the existence of the natural resources such as water, energy and biodiversity including food and ultimately human settlements. Kenya is particularly vulnerable to the impacts of climate change because of factors such as varied ecological zones, overdependence on agriculture, recurrent droughts and floods and widespread poverty. There are many ways that climate change affects human settlements directly or indirectly in this country, and these include, extreme climate conditions such as floods, landslides, droughts and sea level rise. Climate change related catastrophes displace populations and are sometimes disastrous. According to (NCCRS, 2010) landslides caused by heavy storms have in the past claimed many lives especially in the highlands of Kenya.

Erratic climate events such as floods affect human health, through incidences of water-borne diseases like cholera and bilharziasis. In addition rising temperatures which are related to climate change contribute to resurgence of diseases such as malaria and yellow fever. Additionally, reduced water availability and associated lack of safe drinking water and sanitation leads to increased incidences of water-borne diseases, mainly in ASAL areas. According to NCCRS (2010), the country is spending more on health sector because of impacts of climate change.

Kenya is experiencing unprecedented levels of urbanization with increasing proportion of population moving to urban areas due to various factos including loss of livelihood due to climate change. As a consequence some of the immigrants end up living in informal settlements (slums). This proliferation of the informal settlements has lead to increased poor sanitation, inadequate social and physical infrastructural services, environmental degradation and insecurity among other factors. According to (NCCRS, 2010) disease outbreaks create enormous social, helath and infrastructural management challenges in urban areas.

3.1.5.3 Activities in Human Settlements, Health and Safety Sector Related to Climate Adaptation, Relevant Policies and Programs

Activities in human settlements, health and safety related to climate change are mentioned in the Social Pillar of Vision 2030 (GoK, 2007), and emphasizes building a cohesive and prosperous society that enjoys equitable social development in a clean and secure environment. The same activities are also elaborated in other government policies and programmes.

The socio-economic development of the Kenyan people is heavily dependent on climate and other natural resources and improving the environmental policy is critical to climate change adaptation. The Environment Management and Coordination Act (EMCA, 1999) primary objective is to coordinate management of the environment. The environmental management of Vision 2030 is to have relevant legislation of relevant laws and regulation for stricter enforcement especially in land use management, building and construction, health and safety of the people.

To alleviate the shortfall of urban housing and to curb the mushrooming of informal settlements/slums, various interventions and strategies have to be adopted. In session paper no.3 on National Housing Policy Development, the government correctly accepts the fact that it cannot meet the housing shortfall on its own and that the best policy is to encourage the participation of the private sector in provision of housing while the government provides an enabling environment for development.

Disasters like droughts, floods, pestilences, seismic occurrences are likely to occur due to climate change. Vision 2030 seeks to implement adaptation programmes in high risk zones. This will be accompanied by an improved disaster preparedness strategy including early warning systems, public awareness programmes, avoidance and preparedness campaign.

3.1.5.4 Opportunities for Adaptation in Human Settlements, Health and Safety Sector Related to Climate Adaptation, Relevant Policies and Programs

The vision for environmental sector in Vision 2030 (GoK, 2007) is "a nation living in a clean, secure and sustainable environment". This however has to factor in the impact of climate change which is now real and undisputed in the country. Opportunities for adaptation to climate change in human settlements, health and safety exist. In human settlements the opportunities include proper land use planning, sustainable management of natural resources including water and biodiversity, conservation agriculture and use of renewable and efficient energy. In health, opportunities for adaptation include promoting preventive health care and to treat diseases at the community level and opportunities for human safety include early warning systems, public awareness programmes, avoidance and preparedness campaign.

3.2 Process, Criteria and Results of Sector Selection

The process for sector prioritization in TNA for adaptation to climate change in Kenya was carried out in a participatory and consultative manner, to ensure maximum local stakeholder ownership of the project. The TNA project employed a Multi-Stakeholder Process (MSP) approach. With the bottom-up approach in mind, the TNA coordinator and staff of the National Environment Management Authority (NEMA), with assistance from the Consultant, carried out a stakeholder mapping exercise prior to the Inception Workshop (IW). The tentative climate change adaptation list of identified sectors was developed and presented, for approval, to the National TNA Committee before presentation to stakeholders. The list of stakeholders was presented in the first IW held in June 2011 for validation.

The following approaches were used to select and prioritize sectors for TNA adaptation:

a) Involvement of stakeholder on the basis of sector interests through meetings, workshops: During the first stakeholder workshop, technical working groups (Agriculture and Livestock; Forestry, Wildlife and Tourism; Human Settlements; Water Resources, Health and Safety, and Marine and Coastal Zones) were formed and the participants discussed and selected key sectors relevant to climate change adaptation (see Annex 3.1 for the groups report). In a second workshop, held in February 2011, stakeholders contributed to prioritization of technologies in agriculture and water sectors. The third stakeholders workshop, held in Nairobi July 2012, validated technologies for TNA developed through stakeholder consultative process.

b) Consultations and networking from the regional training workshops,

c) Consultation with International Consultants (ENDA and UNEP Risoe) through telephone, E-mails and video conferences:

d) One to one engagement through administration of a questionnaire (see Annex 3 for a sample TNA questionnaire). In the questionnaire, the stakeholders were requested to suggest and list relevant TNA sectors in order of priority, in line with the criteria outlined below. Analysis was then done on the questionnaires and averages of the scores for each technology were used to prioritize the sectors. The analysis results are presented in Annex 3.2.

The criteria for Sector identification was based on expert knowledge which was augmented by detailed literature review of the national development plans and programs and strategies; past and current documents on activities related to climate change adaptation; sectoral reports, plans and strategies and IPCC documents and other relevant documents. With information from the review and use of expert knowledge, the consultants identified the initial list of sectors, based on:

- National development priorities.
- Key economic sectors and their contribution to the national economic development. The sectors identified included agriculture, forestry and land use, water resources including marine and coastal resources, human settlements, health and safety.
- The sector's vulnerability to impacts of climate change and activities in the sector with respect to climate change adaptation.

The prioritization processes lead to selection of Agriculture and Water Resources sectors as priority TNA adaptation sectors for Kenya and will therefore provide the basis for climate change adaptation technologies in Chapter 4 and 5 of this TNA report.

CHAPTER 4: TECHNOLOGY PRIORITIZATION FOR WATER RESOURCES SECTOR

4.1 Current Status of Existing Technologies in the Water Resources Sector

Water endowment in Kenya is low and the demand for renewable freshwater outstrips supply, with only 57% of households using water from sources considered safe (MW&I, 2010). The distribution of water availability is dependent on rainfall patterns in the country, and varies from (0) to about 250 mm in the Arid and Semi arid areas (ASAL) such as Garissa, Isiolo, Mandera, Marsabit, Moyale, Turkana, among others; to 2,000 mm in high potential areas such as Nyeri, Meru, Nyandarua, Mt. Elgon regions, among others (MW&I, 2010). There can be large seasonal variation in rainfall such that during the long dry season, water shortage is experienced in many river basins, while during the rainy season severe floods cause tremendous damage in the same river basins. Kenya is therefore vulnerable to climate variability and change, and the now recurrent droughts and flush floods is pointer to the evolving and predicted scenario.

The existing technologies and practices in Kenya include:

(a) *Water abstraction from surface water sources:*
Water is usually pumped using diesel or electric powered pumps form the source (rivers, lakes or dams) to either directly to the consumers or to the treatment works where it is chemical treated for distribution to consumers. This is the main technology for many parts of the country but in the arid and semi-arid areas it is limited by scarcity of surface water sources and therefore, other technologies are normally used.

(b) *Water harvesting,*
Water harvesting is the collection of runoff for productive purposes. Instead of runoff being left to cause erosion, it is harvested and utilized. In the semi-arid drought-prone areas where it is already practised, water harvesting is a directly productive form of soil and water conservation. Both yields and reliability of production can be significantly improved with this method. Water harvesting systems include those based on roof, rock, tree trunks, and roadside catchments; land surface runoff; and other flush flood runoff (FAO 1991).

(c) *Construction of surface and sub-surface dams and pans in ASAL areas to store excess surface runoff,*
This is envisioned in the Vision 2030 and elaborated in the National Water Harvesting and Storage Management Policy (MW&I, 2010) as a way of addressing the challenges of inadequate water supplies and ineffective control of periodic floods in the country. The goal is to develop water harvesting and storage capacities up-to 4.5 Bm^3 over the next ten years by realizing at least 340 Mm^3 of additional storage annually, through construction of large, medium and small dams in addition to water pans, rock, roadside and roof catchments systems and other runoff channels or lagoons.

(d) *Groundwater abstraction,*
Exploitation of groundwater has been on increasing trend, especially in the ASAL areas where surface water is in short supply or unavailable. The government is encouraging individuals, groups and communities, through development of appropriate policies and provision of financial assistance to utilize groundwater (e.g. GoK, 2010).

(e) *Water efficient technologies such as water saving tap and shower heads and efficient toilet cisterns which use less water*
These are available in the market but their use is on basis of individual preference. There is however need to develop a policy on to encourage widespread use and initiating public sensitisation initiative on the benefits and to introduction of tax rebates on water saving appliances.

(f) Eco San-toilets

Eco San-toilets are designed to separate solid human waste and liquid waste. Solid waste is dried and latter used as fertiliser for domestic gardens and liquid waste is similarly used as nitrogen rich fertiliser in the gardens (International Water Association, 2003). They are currently being popularised by some NGOs and government agencies and have been installed in some homes and markets for demonstration purposes. There is, however, need to create more public awareness in order to address the cultural hangovers associated with handling of human waste. Funding and capacity building is also required to enhance accessibility in all regions.

(g) Policies and regulations to encourage efficient water use, including water pricing

One of the widely used policy is water pricing. Water pricing is widely used by the water companies and involves charging increasing higher unit prices the more water one consumes.

(h) Awareness raising campaigns to encourage efficient water use and conservation of water resources

This is occasionally done by the water companies and the Ministry of Water and Irrigation using print and electronic media. Much more, however, should be done to increase coverage and enhance knowledge

(i) Catchment protection including afforestation and soil conservation techniques for example building terraces and planting cover crops

Afforestation of degraded catchment is currently a national priority with initiatives by government, non-government and local individuals being undertaken. The conservation and rehabilitation of the main water towers including Mau, Aberdare, and Mount Kenya forests is currently a national policy issue (GoK, 2010). Soil conservation techniques such as building of terraces and planting cover crops have been in use in Kenya for many years and are actively promoted by Ministry of Agricultural and other government (e.g. MW&I, 2010)

4.2 An Overview of Possible Adaptation Technology Options in the Water Sector

Following stakeholder consultations through workshops, administration of structured questionnaires together with review of relevant development and policy documents facts several technologies were selected for adaptation to climate change in water resources sector. The technologies were selected based on the following criteria:

i) Technology has not been successfully implemented in the country
ii) Technology is innovative
iii) Technology is facing barriers in its implementation
iv) The technology has potential areas to formulate fundable projects

The following were selected as key technologies for adaptation to climate change in water resources sector in Kenya:

a) Roof Rainwater harvesting,
b) Surface Runoff Water Harvesting
c) Reuse of Treated Wastewater for Irrigation
d) Construction of Sand Dams,
e) Drilling of boreholes,
f) Solar powered desalination

Fact sheets were then prepared for each selected technology, using information from relevant literature and consultation with stakeholders. A summary of characteristics of the selected technologies are presented in Table 4.1. Detailed information on the technologies is contained in the respective technology fact sheets in Annex 1.0.

Table 4.1: Summary of characteristics of selected adaptation technologies for water resources

Technology	Characteristics	Status of implementation in the country
Roof Rainwater harvesting,	The technology involves collection and storing of rainwater from rooftops, using simple techniques water holding tanks	Adopted in some parts of the country but adoption and diffusion in may parts facing several barriers
Surface runoff water harvesting	Surface runoff water harvesting involves accumulation and storing of storm water for its eventual reuse.	Adopted in some parts of the country but adoption and diffusion in may parts facing several barriers
Treatment of Wastewater for Reuse	The extent to which treated wastewater can be reused depends on the level of treatment that has been carried out. Tertiary treatment with disinfection is required for safe use of domestic water for irrigation	Currently technology not practiced in the country
Construction of Sand Dams,	A sand storage dam (or sand dam) is a small dam build Involves construction of small dam on and into the riverbed of a seasonal sand bottom river in order to abstract the flow of groundwater and create additional groundwater storage for the community.	Practiced in some parts of the country but adoption and diffusion in may parts facing several barriers
Drilling of boreholes,	Borehole drilling makes use of a drilling rig to sink a borehole for water abstraction.	Adopted at different levels in various parts of the country but adoption and diffusion in may parts facing several barriers
Solar Powered Desalination	Desalination, involves removing the salt and other ions (and pollutants) from water to make it drinkable using reverse osmosis powered using solar energy.	Currently only 1 desalination facility exist, in Kizingitini Island, with a capacity of 4000 liters per day

4.3 Criteria and Process of Technology Prioritization

The selected technologies (4.2 above) were prioritized using Multi-Criteria Analysis (MCA) in order to identify 3 technologies for further analysis and transfer and adoption in Kenya. MCA is a decision making support tool which is used to carryout assessment based on monetary and non-monetary criterias. It is a useful tool in decision making involving several actors with different and often contradictory objectives (enda, 2011). The MCA was done using a computer based model, Definite 2.0, according to the following steps:

a. Identification of criteria (effects) for technology selection:

The following criteria were identified, following wide consultation with stakeholders, and used as input into the model:

1. Adaptation to local conditions
2. Cost of implementing the technology: The cost was based on water supply to 200 households, which allowed for comparison between the technologies
3. Contribution to poverty reduction
4. Contribution to climate change adaptation
5. Contribution to national water security

b. Grading of technologies using each effect (criteria)

This involved assigning criteria scores for each technology based on selected interval (Table 4.2) in order to assist in ranking the technologies

Table 4.2: Assigned criteria Scores for the selected technologies

	Range	Roof rain water harvesting	Surface runoff water harvesting	Solar Powered Desalination	Construction of sand dams	Drilling of boreholes	Treatment of Waste-water for Irrigation
Adaptation to local conditions	3-10	10	5	6	8	4	3
Cost of implementing the technology	10000-600000	67500	75000	600000	10000	37500	100000
Contribution to poverty reduction	7-20	20	16	18	13	12	7
Contribution to climate change adaptation	3-10	9	10	7	5	6	3
Contribution to national water security	6-20	19	20	14	9	10	6

c. Standardisation

Standardisation involved putting the scores of all the criteria into a single scale (0-1). This was done in the model by selecting the interval model which allows interpolation of the effect scores from 0 for the worst and one for best effect score. This facilitated the comparison of the technologies based on all criterias. The scale of the technology cost criteria was reverse of the other criteria since cost is negative: i.e. 0 for highest cost and 1 for the lowest cost. The standardised scores and averages for each technology are shown in Table 4.3.

Table 4.3: Standardized criteria scores and average scores for the selected technologies

	Roof rain water harvesting	Surface runoff water harvesting	Solar Powered Desalination	Construction of sand dams	Drilling of boreholes	Treatment of Waste-water for Irrigation
Adaptation to local conditions	1.0	0.29	0.43	0.71	0.14	0.0
Cost of implementing the technology	0.9	0.89	0.0	1.0	0.95	0.85
Contribution to poverty reduction	1.0	0.69	0.85	0.46	0.38	0.0
Contribution to climate change adaptation	0.86	1.0	0.57	0.29	0.43	0.0
Contribution to national water security	0.93	1.0	0.57	0.21	0.29	0.0
Average Score	**0.938**	**0.774**	**0.484**	**0.534**	**0.438**	**0.17**

d. Weighting the criteria

After standardisation, the criteria scores were then assigned weights, over a selected range, depending on the agreed relative importance by different experts involved (Table 4.4). After weighting the technologies were assigned scores based on the standardised scores and the assigned weight which allowed for prioritisation of the technologies.

Table 4.4: Assigned and standardized weight

	Assigned Weight (0 to 10)	**Standardized Weight (0-1)**
Adaptation to local conditions	1.0	0.43
Cost of implementing the technology	0.0	0.0
Contribution to poverty reduction	5.0	0.22
Contribution to climate change adaptation	10.0	0.44
Contribution to national water security	7.0	0.30

4.4 Results of Technology Prioritization

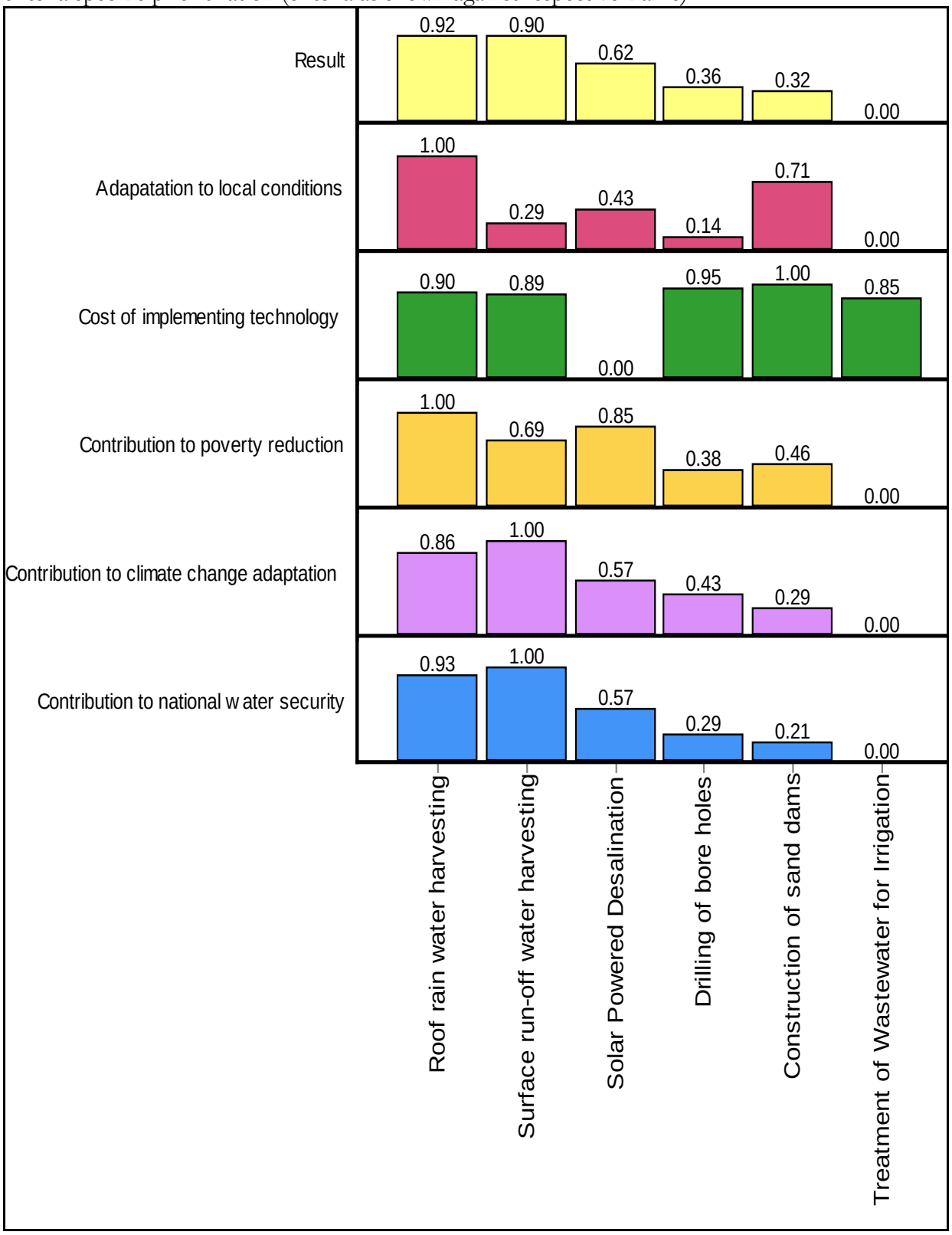
Figure 4.1 shows the results of technology prioritization following MCA analysis. The technologies with the highest scores are Roof rain water harvesting, Surface runoff water harvesting and Solar Powered Desalination with scores of 0.92, 0.90 and 0.62 respectively and are therefore selected for further analysis, development and adoption for Kenya. The other two technologies in order of priority were drilling of boreholes and construction of sand dams (0.36 and 0.32 respectively). Treatment of wastewater for irrigation had the lowest score of zero.

Comparing Table 4.3 and Figure 4.1 shows the general agreement in ranking of technologies except the solar powered desalination which was placed in rank 4, whereas after weighting it was ranked number 3. However, the scores were different for the two outputs.

After stakeholders consultation on the relevance of the technologies to social and economic welfare of this country the following technologies were recommended:

1. Surface runoff water harvesting
2. Roof rain water harvesting

Figure 4.1: MCA results for prioritization of adaptation technologies, after weighing (first frame) and criteria specific prioritization (criteria as shown against respective frame)



CHAPTER 5: TECHNOLOGY PRIORITIZATION FOR AGRICULTURE SECTOR

5.1 Adaptation Technology Options for Agriculture Sector

The measures and technologies that can be implemented for adaptation to climate change in the Agriculture Sector include:

a) *Introduction of Drought Tolerant Sorghum*

The rainfall pattern is unreliable in most parts of the country and droughts have become more frequent. Therefore there is need for development and introduction of high yielding, drought tolerant, early maturing crop varieties, such as drought tolerant sorghum, in order to enhance food security in the country. Some examples include the Super Sorghum, a high yielding and drought tolerant variety which is currently being promoted in Western Kenya, and Sila sorghum variety, which has been identified by Kenya Breweries as an alternative to barley beer production (Khamsin, 2011).

b) *Drip Irrigation*

Drip Irrigation which is a technique of application of specific and focused quantities of water to soil crops. The system uses pipes, valves and small drippers or emitters transporting water from the sources to the root area and applying it under particular quantity and pressure specifications. Drip irrigation can provide as much as 90 per cent water-use efficiency in contrast to surface irrigation and sprinkler systems, which provide 60 per cent 75 per cent efficiency respectively, and can therefore enable farmers to adapt to climate change in crop production under erratic rainfall pattern (Quezada et al., 2012).

c) *Conservation Tillage*

This adaptation method involves growing crops with minimal disturbance in the soil.
It aims at achieving sustainable and profitable agriculture and eventually improves farmer's livelihoods through the application of the three CA principles: minimal soil disturbance; permanent soil cover and crop rotation. This method of farming increases crop production while conserving resources (soil and water) and protecting the environment (Quezada et al 2012). It is suitable for a range of crops such as grains, vegetables, root crops, sugarcane, cassava, fruits and vines.

d) *Biotechnology – Tissue Culture Banana*

Biotechnology involves breeding crops for improved performance under environmental stresses. The technology has been piloted, tested and is commercially available for some crops such as bananas, maize, soya beans, cowpeas, rice, cowpeas and beans. In Kenya Tissue Culture Banana techniques have been adapted widely in many parts of this country. The Kenya Bio-safety Authority is responsible for regulating research and application of biotechnology.

e) *Early Warming Systems for Crop Production*

This is a method of conveying meteorological information on seasonal rainfall patterns and climate change and variability. This enables farmer and other stakeholders get information on seasonal rainfall characteristics and patterns in order to adapt to climate variability (Quezada et al 2012).

f) *Hay Preservation*

Hay making is the process of turning green, perishable forage into a product that can be safely stored and easily transported without danger of spoilage while keeping the nutrient loss to a minimum. The technology is especially important in adapting to effects of climate change in arid and semi arid areas (Suttie 2000). Hay making is important for dry areas where there are likely to be shortage of forage during the drought. Hay making

conserves forage during the rainy season for use during the dry season when forage is scarce. Hay making operations for small-scale farmers vary from those of large scale operator sin terms of tools, equipment, machinery and infrastructures used for: harvesting the grass (cutting or mowing); tending, raking, bailing adding drying agents and preservatives (at times) and storage.

5.2 Criteria and process of Technology prioritization

The process and criteria was conducted in a participatory and an all inclusive way. It was also based on the sector's contribution to national development and their relationship to climate change adaptation. The following steps were undertaken:

a) Detailed literature review and use of expert knowledge: A detailed literature review of the national development plans and programs and strategies; past and current documents and activities with respect to climate change and adaptation; sectoral reports, plans and strategies and IPCC documents and other climate change related activities.
b) Involvement of stakeholder through meetings, workshops, one to one engagement and questionnaire administration (Annex 2.7).
c) Consultations and networking during the regional training workshops

The following were identified as key technologies for Climate Change adaptation in agriculture sector:-

- Drought resistant sorghum
- Hay preservation
- Drip Irrigation
- Tissue Culture Banana through Biotechnology
- Early Warning System
- Conservation Tillage

Fact sheets were then prepared for each selected technology, using information gathered from relevant literature and consultation with stakeholders. Fact sheets for the selected technologies are presented in Annex 1.0.

5.3 Results of Technology Prioritization

The six identified Climate Change Adaptation Technologies were then prioritized using Multi Criteria Analysis Method. Multi Criteria Analysis (MCA) is a decision making and is designed to give decision-makers a practical evidence-based approach to setting priorities and choosing between alternatives choices.

The process is interactive and makes use of a computer–based model (Definite 2.0) to aid the process and feed back to participants the effects of changes as they explore decision options. The criteria that were used were: adaptation to climate change, cost of technology, contribution to economic development, contribution to food security, and adaptation to local conditions.

During MCA multi criteria analysis, scores and weighting and standardization concepts were applied for technology prioritization (see tables 5.1, 5.2 and 5.3 and Figures 5.1)

The following technologies were subjected to MCA for prioritization.

- Drought tolerant sorghum
- Drip irrigation
- Conservation Tillage
- Biotechnology – Tissue Culture Banana
- Early Warning System

- Hay Preservation

The multi criteria analysis, Weight Effects and the Ranking of the Technologies are given in the Tables 5.1, 5.2, 5.3, Figure 5.1 below:

Table 5.1: Agriculture Sector: Multi Criteria Analysis Scores

CRITERIA	UNITS	TECHNOLOGIES					
		Drip Irrigation	Drought Tolerant Sorghum	Conser-vation Tillage	Biotech-nology Tissue Culture Banana	Early Warning System	Hay Preser-vation
1. Adaptation to Climate Change	(1-5)	4	5	1	3	2	5
2. Cost of Technology	US $	250	115	12.5	232.5	1000	6.5
3. Contribution to Economic Development	(1-10)	9	8	3	7	5	6
4. Contribution to food security	(1-5)	4.5	5	2	3	3	4
5. Adaptation to local conditions	(1-10)	7.3	8.6	4	7	5	8.5

Table 5.2: Standardization and Weighting of the Effects

CRITERIA (Range 0-10)	Unit	Standardization Method	Minimum Range	Maximum Range	Assigned Weight	Generated Weight
1. Adaptation to Climate Change	1 – 5.0	Internal	1.0	5.0	10	0.333
2. Cost of Technology	US $	Internal	6.5	1000	2	0.067
3. Contribution to Economic Development	1-10	Maximum	0.0	9.0	7	0.233
4. Contribution to Food Security	1-5	Internal	2.0	5.0	8	0.267
5. Adaptation to local conditions	1-10	Internal	4.0	8.6	3	0.100

Table 5.3: Standardized criteria scores and average scores for the selected technologies

	Drip Irrigation	Drought Tolerant Sorghum	Conservation Tillage	Biotechnology Tissue Culture Banana	Early Warning System	Hay Preservation
1. Adaptation to Climate Change	0.75	1.0	0.0	0.5	0.25	1.0
2. Cost of Technology	0.75	0.89	0.99	0.77	0	1.0
3. Contribution to Economic Development	1.0	0.83	0.0	0.67	0.33	0.5
4. Contribution to food security	0.83	1.0	0.0	0.33	0.33	0.67
5. Adaptation to local conditions	0.72	1.0	0.0	0.65	0.22	0.98
Average Score	**0.81**	**0.944**	**0.198**	**0.584**	**0.226**	**0.83**

Table 5.4: Ranking of Technologies

	Technology	**Weight**
1.	Drought Tolerant Sorghum	0.97
2.	Hay Preservation	0.83
3.	Drip Irrigation	0.83
4.	Biotechnology - Tissue Culture Banana	0.55
5.	Early Warning System for Crop Production	0.32
6.	Conservation Tillage	0.14

5.4 Recommended Technologies

After stakeholders consultation on the relevance of the technologies to social and economic welfare of this country the following technologies were recommended:

1. Drought Tolerant Sorghum Variety.
2. Drip Irrigation.

Figure 5.1: MCA results for prioritization of adaptation technologies, after weighing (first frame) and criteria specific prioritization (criteria are shown against respective frame)

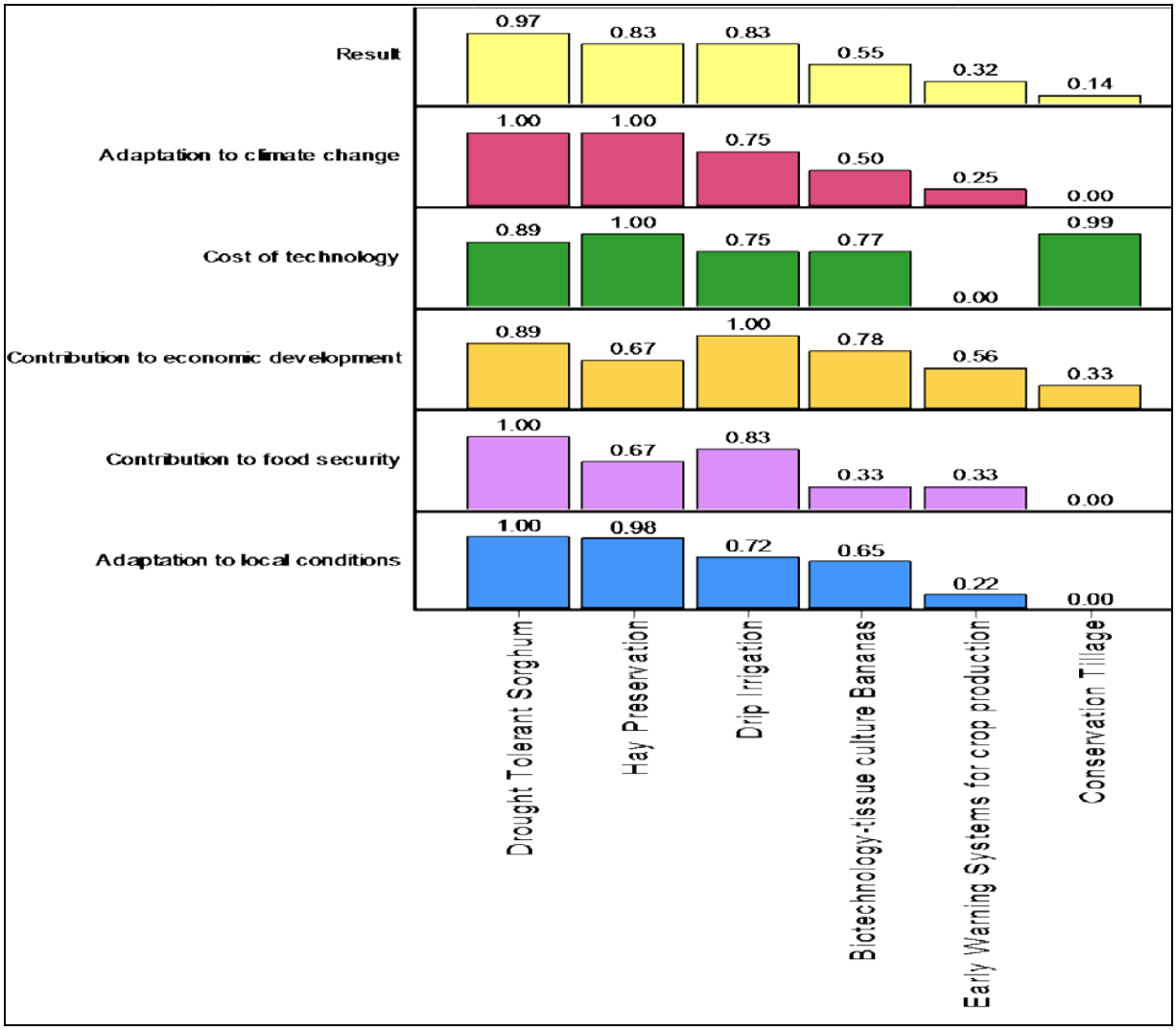


Table 5.5: Tabulated Description of the Technologies

Alternative	Description	Prioritized Score
Drip Irrigation	Efficient water supply to crops	0.83
Drought Tolerant Sorghum	Introducing and popularizing drought tolerant sorghum variety	0.97
Conservation Tillage	Method of farming involving growing crops with minimal disturbance in soils to conserve resources and protect the environment by drilling seed	0.14
Biotechnology-tissue culture Bananas	Using biotechnology to breed bananas for improved yields under water stress conditions	0.55
Early Warning Systems for crop production	Method of conveying meteorological information on seasonal rainfall patterns, and climate change and variability	0.32
Hay Preservation	Method to preserve forage produced during rainy season for use during dry season	0.83

CHAPTER 6: SUMMARY AND CONCLUSIONS

It is evident that Kenya has been impacted negatively by climate change. Droughts and floods have become frequent, intense and unpredictable. Therefore technology needs to address climate change are therefore necessary and prudent if this country has to sustain socio-economic development and maintain her people's livelihoods.

This TNA Report is a result of consultative process of prioritization of adaptation sectors as well as identifying climate change technologies from the prioritised sectors. The sectors prioritised in the report are water and agriculture. The prioritized technologies for Water sector are Surface runoff water harvesting and Roof rain water harvesting,. In Agriculture sector Drought Tolerant Sorghum Variety; and Drip Irrigation were prioritized. The TNA report will form the basis for the next phase of the project which is - Barrier Analysis and Enabling Framework Report, the Technology Action Plans and Project Ideas.

Kenya stands to benefit immensely from the transfer and diffusion of appropriate technologies, technical know-how and financial resources to enable the country adapt to climatic change. The Government supports the on-going process, which will enable the Kenyan people implement technologies for climate change adaptation to help them remain in the sustainable development pathway.

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ANNEXES

ANNEX 1.0: TECHNOLOGY FACT SHEETS ON ADAPTATION
ANNEX 1.1: WATER SECTOR FACT SHEETS

1. TECHNOLOGY:	SOLAR POWERED SEAWATER DESALINATION
A1. Introduction	Desalination, involves removing the salt and other dissolved constituents from seawater, brackishwaters, wastewater or contaminated freshwater to make it drinkable (Elliot et al. 2011). Desalination is widely used as a freshwater source in water scarce arid and its application is expected to increase as freshwater resources are stressed by population growth, rural-urban migration and effects of climate change (Elliot et al. 2011).
Technology Characteristics	There are several ways to do it. The principal desalination methods fall into two categories namely thermal processes and membrane processes. Thermal desalination processes use heat to evaporate water, which is then condensed and collected as pure water, leaving dissolved constituents behind. The most common thermal desalination process is multistage flash (MSF) distillation, and is normally linked to power plants to utilize waste heat and therefore reduce energy requirements (Elliot et al. 2011) Membrane desalination processes utilize high pressure to force water molecules through very small pores while retaining salts and other large molecules. Reverse osmosis (RO), the most widely membrane method, uses pressure to force water molecules in the direction against the osmotic pressure (Elliot et al 2011). To overcome osmotic pressure energy is required, and the source of energy can be e.g. from solar energy.
Country Specific Applicability & Potential	Kenya has a 534 km coastline, whose world class beaches attract millions of tourists annually. The tourism and other associated industries have over the years attracted ever expanding human population. The current and future projected water stress in the region will require new sources of drinking water and desalination will be very handy as it will be able to tap on the immense marine water. Desalination will especially be applicable in the numerous hotels and numerous coastal and island communities where access to freshwater has increasingly being a challenge, a problem which is expected to increase with climate change. Many areas in the coastal region depend on groundwater as drinking and industrial water source, which is faced with the danger of salt water intrusion due to climate change induced sea level rise. The application of the desalination will be a key technology in addressing this challenge
Status of Technology in Kenya	Currently desalination has not been widely adopted in Kenya, mainly due to the perceived costs associated with acquiring the technology and possibly due low level of technology transfer. However, in Kizingitini Island, the Red Cross (ICRC) has put up a desalination plant with a capacity of 4000 litres per day, a boost to this parched island community. The community has traditionally relied on the rains for drinking water, which fall between October and December for the short rains and March and May for the long rains. However, weather patterns have been unreliable leaving the residents without drinking water for many parts of the year

Benefits to Economic/ Social and Environ-mental Development	• Drinking water for domestic and industrial purposes in coastal region and other regions with high salt content groundwater • Co-production of table salt will reduce environment impact of the production waste and be economically valuable • Availability of freshwater to enhance growth of tourism and other service industries • Reduce overexploitation of ground and service water with consequent environmental benefits • Job Creation with regards to implementation, operation and maintenance. • Reduce public and private expenditures associated with water infrastructure.
Climate Change Adaptation Benefits	Short-term drought and longer-term climatic trends of decreased precipitation can lead to decreased water availability per capita. Desalination can contribute to climate change adaptation through diversification of water supply and resilience to water quality degradation (Elliot et al. 2011). Desalination technologies also provide resilience to water quality degradation because they can usually produce very pure product water, even from highly contaminated source waters. Increasing resilience to reduced per capita freshwater availability is one of the key challenges of climate change adaptation. Nevertheless, the large energy demands of current desalination processes will contribute to greenhouse gas emissions and could set back climate-change mitigation efforts (Elliot et al 2011), which makes the use of solar powered desalinators a good technology option.
Financial Requirements and Costs	The cost factors of desalting include capital costs and operating and maintenance costs. Costs can vary considerably from one locality to another based on a number of issues in general; the amount of salt to be removed greatly affects the cost of desalting plant operation. The more salts to be removed, the more expensive the desalting process capacity of the facility also impacts costs, with larger plants generally being more economical. A desalination plant serving 200 households is estimated at US$ 100,000

2. TECHNOLOGY:	**ROOF RAINWATER HARVESTING**
Introduction	Most precipitation that falls on human settlements is lost to the atmosphere through evapotransporation, or runs into rivers away from settlements before it can be used. However, if the rain is collected using appropriate infrastructure, it can contribute greatly to the volume of freshwater available for human use. This is particularly relevant in arid and semi-arid regions, where the little rainfall received is usually very intense and often seasonal (Elliot et al 2011).
Technology Characteristics	Rainwater harvesting is the accumulating and storing of rainwater for reuse before it reaches the aquifer. Rooftop catchments is the most basic form of this technology and include collection of rainwater in gutters which drain to the collection vessel through down-pipes constructed for this purpose, and/or the diversion of rainwater from the gutters to containers for settling particulates before being conveyed to the storage container for the domestic use (Pacey & Cullis, 1986). As the rooftop is the main catchment area, the amount and quality of rainwater collected depends on the area and type of roofing material.

Country Specific Applicability & Potential	The water endowment in Kenya is low and the demand for renewable freshwater outstrips supply, with only 57% of households using water from sources considered safe (MW& I, 2010). The annual per capita availability of renewable freshwater is only 647 cubic meters (m^3), far much lower than the UN recommended amount of 1000 m^3, implying that Kenya can be classified as a water scarce country. There can be large seasonal variation in rainfall such that during the long dry season, water shortage is experienced in many river basins, while during the rainy season severe floods cause tremendous damage in the same river basins. Rainwater harvesting has the potential to alleviate water shortage in Kenya. For example, a report by UNEP, shows that Kenya's capital has the potential to supply the water needs of between six and 10 million people with 60 litres a day if rainwater were efficiently and effectively harvested and that for Kenya as a whole the rainfall contribution is more than adequate to meet the needs of the current population several times over if rainwater harvesting is fully implemented.
Status of Technology in Kenya	Kenya's water policy takes into account all the relevant issues including water conservation and preservation of its quality. In this regard, mainstreaming of rainwater harvesting is very prominent. In agricultural production, rainwater harvesting is mainstreamed into the soil and water conservation. This approach promotes rainwater harvesting on the field thus minimizing run off. Through a presidential initiative, district competitions are held to encourage farmers in water and soil conservation. Initially the emphasis was more on soil conservation but there has been a shift in thinking towards rainwater harvesting and soil conservation as equally important components.
Benefits to Economic/ Social and Environmental Development	The technology will enhance availability of drinking water for domestic and agricultural water for arid and semi-arid areas, contribute job creation and result in reduction of public and private expenditures associated with water infrastructure. Roof rainwater harvesting will contribute to increased availability of freshwater and hence lead to enhanced growth of social structures and women empowerment. It will also reduce overexploitation of ground and service water with consequent environmental benefits
Climate Change Adaptation Benefits	Climate change projection for Kenya indicates general rainfall decrease most of the country, which together with population growth is bound to impact serious strains in existing low freshwater endowment in the country. Collection and storage of rainwater can provide a convenient and reliable water supply during seasonal dry periods and droughts.
Financial Requirements and Costs	Rainwater harvesters for 200 households is estimated to cost US$ 67,500

3. TECHNOLOGY:	SURFACE RUNOFF WATER HARVESTING
Introduction	Most precipitation that falls on human settlements is lost to the atmosphere through evapotransporation, or runs into rivers away from settlements before it can be used. However, if the rain is collected using appropriate infrastructure, it can contribute greatly to the volume of freshwater available for human use. This is particularly relevant in arid and semi-arid regions, where the little rainfall received is usually very intense and often seasonal (Elliot et al 2011).
Technology Characteristics	Surface runoff water harvesting is the collection, accumulation, treatment or purification, and storing of stormwater for its eventual reuse. It can also include other catchment areas from manmade surfaces, such as roads, or other urban environments such as parks, gardens and playing fields. Surface runoff water is an excellent alternative to using mains drinking water for many purposes. If properly designed, Surface runoff catchment systems can collect large quantities of rainwater. The main challenge Surface runoff water harvesting poses is the removal of pollutants in order to make this water available for reuse. Small reservoirs with earthen bunds or embankments to contain runoff or river flow are built from soil excavated from within the reservoir to increase storage capacity and a spillway or weir allows controlled overflow when storage capacity is exceeded (Elliot et al 2011). The reservoirs can vary in size from less than a hectare to up to 12 ha.
Country Specific Applicability & Potential	The water endowment in Kenya is low and the demand for renewable freshwater outstrips supply, with only 57% of households using water from sources considered safe (MW& I, 2010). The annual per capita availability of renewable freshwater is only 647 cubic meters (m^3), far much lower than the UN recommended amount of 1000 m^3, implying that Kenya can be classified as a water scarce country. There can be large seasonal variation in rainfall such that during the long dry season, water shortage is experienced in many river basins, while during the rainy season severe floods cause tremendous damage in the same river basins. Rainwater harvesting has the potential to alleviate water shortage in Kenya. For example, by UNEP, shows that Kenya's capital has the potential to supply the water needs of between six and 10 million people with 60 litres a day if rainwater were efficiently and effectively harvested and that for Kenya as a whole the rainfall contribution is more than adequate to meet the needs of the current population several times over if rainwater harvesting is fully implemented.
Status of Technology in Kenya	Kenya's water policy takes into account all the relevant issues including water conservation and preservation of its quality. In this regard, mainstreaming of rainwater harvesting is very prominent. In agricultural production, rainwater harvesting is mainstreamed into the soil and water conservation. This approach promotes rainwater harvesting on the field thus minimizing run off. Through a presidential initiative, district competitions are held to encourage farmers in water and soil conservation. Initially the emphasis was more on soil conservation but there has been a shift in thinking towards rainwater harvesting and soil conservation as equally important components.

Benefits to Economic/Social and Environmental Development	• Creation of jobs as this technology will require trained staff to operate and maintain the system. • This will result in additional water for irrigation, and thus the potential to promote development. • Reduce public and private expenditures associated with water infrastructure • Water for irrigation will be available and will not compete with other users. • This water can also contribute to productive and economic livelihood purposes. • Increases per capita water availability for irrigation purposes. • By collecting storm water, this will result in an reduction in the loss of water to the sea and also a decrease in the discharge load on receiving waters, and in addition a reduction in the demand of already harnessed fresh water.
Climate Change Adaptation Benefits	Climate change projection for Kenya indicates general rainfall decrease most of the country, which together with population growth is bound to impact serious strains in existing low freshwater endowment in the country. Harvesting surface runoff during rainy season and storing it for use during the dry season will play an important role in contributing to adaptation to water shortage occasion by prolonged droughts associated with climate change. Additionally, widespread rainwater storage capacity can greatly reduce land erosion and flood inflow to major rivers. Rainwater collection can also contribute greatly to the stabilization of declining groundwater tables (Elliot et al 2011).
Financial Requirements and Costs	The cost of construction of a retainer dam depend on the size of the project and location but estimates for a small dam serving 200 households in about US$ 75,000.

4. TECHNOLOGY:	**REUSE OF TREATED WASTEWATER FOR IRRIGATION**
Introduction	Wastewater is used water. It includes substances such as human waste, food scraps, oils, soaps and chemicals. In homes, this includes water from sinks, showers, bathtubs, toilets, washing machines and dishwashers. Businesses and industries also contribute their share of used water that must be cleaned.
Technology Characteristics	Typical wastewater treatment schemes incorporate multiple levels of physical, biological, and chemical treatment in order to ensure that water discharged to the environment does not pose a significant risk of adverse environmental or health impacts (Elliot et al 2011). The extent to which treated wastewater can be reused depends on the level of treatment that has been carried out. The main concern for reuse of treated wastewater for irrigation is the risk for microbial contamination of the irrigated crops. Primary, secondary and even tertiary treatment cannot be expected to remove 100 percent of the incoming waste load and as a result, many organisms still remain in the waste stream. In order to destroy pathogens, disinfection/sterilization will be needed in order to destroy micro-organisms, depending on the intent reuse.

Country Specific Applicability & Potential	A number of major towns in Kenya have sewerage treatment facilities, maturation ponds. The treated effluent from these plants can be used for irrigation agriculture and aquaculture farming to supplement food requirements in these urban areas. Additionally, manufacturing industries using a lot of water and hence producing high waste water effluent discharge can treat and reuse the wastewater for cooling and other operation not requiring high quality water and for water grass and plants in the compounds. Given the water stress status of Kenya the project impact of water resources and availability due to climate change re-use of waste water, both domestic and industrial will go along way in easing the water stress.
Status of Technology in Kenya	The reuse of the treated for agriculture, aquaculture and other purposes is not common and the water, after treatment, is usually discharged into the nearby water bodies. However, in some urban areas uncontrolled irrigation of vegetable gardens for commercial purposes, sometimes using untreated wastewater, is practiced, which has in the recent pact raised public health concerns.
Benefits to Economic/Social and Environ-mental Development	• Creation of jobs as this technology will require trained staff to operate and maintain the system. • This will result in additional water for irrigation, and thus the potential to promote development. • Reduce public and private expenditures associated with water infrastructure. • Water for irrigation will be available and will not compete with other users. • This treated water can also contribute to productive and economic livelihood purposes. • Increases per capita water availability for irrigation purposes. • By treating and reusing the treated wastewater this will result in an reduction in the discharge load on receiving waters, and in addition a reduction in the demand of already harnessed fresh water.
Climate Change Adaptation Benefits	Re-use of treated wastewater will contribute to the reduction of water deficit occasioned by climate change and also reduce incidences of crop failures due to more recurrent draughts. Additionally it contributes to climate change adaptation by allowing water resources to be diversified and conserved are treated wastewater can be applied to permeable land surfaces or directly injected into the ground for the purpose of recharging groundwater aquifers and preventing saline intrusion in coastal areas (Elliot et al 2011).
Financial Requirements and Costs	The financial implication will mainly be related to the need for expanding treatment works to include a tertiary stage, where it does not exist, and distribution system to the required areas. Estimates for facility serving 200 households is US$ 100,000

5. TECHNOLOGY:	DRILLING OF BOREHOLES
Introduction	Groundwater abstraction is the process of taking water from a ground source, either temporarily or permanently. Abstraction can be either manual, where water table is high or mechanized, usually by using a rotary drilling rig which is able to reach deep aquifers of several hundred meters.
Technology Characteristics	A water borehole is a specially engineered hole in the ground, making provision for water to flow into this hole and allowing for a pump to be installed inside the hole to allow abstraction of water. There are several borehole drilling methods, the two most common being rotary and air percussion methods (Aqua Earth, 2011). In rotary drilling, a drill bit, made of tough metals such as tungsten, is attached to a length of connected drill pipe and as the drill is rotated the bit grind up the rock. Air percussion technique utilizes compressed air to operate a down-hole air hammer on the end of the drill string that helps to break up the rock formation. The compressed air that is used to operate the down-hole air hammer also blows the crushed rock fragments out of the hole to the surface along with any water that flows into the hole during drilling (Aua Earth 2011). Typically, a borehole is completed by installing a vertical pipe (casing) and well screen to keep the borehole from caving and help prevent surface contaminants from entering the borehole and protect any installed pump from drawing in sand and sediment.
Country Specific Applicability & Potential	Groundwater is more immune to the effects of climate fluctuation compared to other sources of water, especially surface water. Therefore, groundwater abstraction will be a vital water source option in the countries adaptation to water shortages occasioned by climate change. The government is encouraging individuals, groups and communities, through development of appropriate policies and provision of financial assistance to utilize groundwater, especially in the ASAL areas where surface water is in short supply or unavailable.
Status of Technology in Kenya	Ground water abstraction is common is Kenya, and in many rural and urban areas with shallow water tables hand dug shallows wells are important domestic water sources. In most areas, the bore-holes needed to abstract groundwater would require a depth of as much as 260 m and the cost of sinking such a bore-hole is high. Drilling of boreholes has continued to increase as an option by the government and private developers to address increasing water demand accession by population growth and supply unreliability occasioned by frequent draughts. For example ground water abstraction in the City of Nairobi has steadily increased and currently account for 25% of the overall water-supply of the population of Greater Nairobi.
Benefits to Economic/ Social and Environ-mental Development	• Availability of good quality water for domestic and agricultural purposes • Women empowerment by providing readily available water and committing time spent looking for water to family and other socio-economic activities • Reduced incidences of water born diseases

Climate Change Adaptation Benefits	Climate Change in Kenya is projected to result to more frequent and severe droughts and associated increased water resources stress, particularly in arid and semi-arid areas. Ground water is relatively less likely to be affected by climate change compared to surface water sources and will therefore be a good water source option especially in arid and semi-arid areas (MW&I, 2010).
Financial Requirements and Costs	The costs of drilling new boreholes vary widely depending on many factors such as aquiver depths, design and the difficulty to construct a borehole in a specific geological formation. However, in Kenya the average cost of drilling and equipping a borehole to serve 200 households is estimated at US$ 37500

6. TECHNOLOGY:	**CONSTRUCTION OF SAND DAMS**
Introduction	Seasonal rivers, mainly found in arid and semi-arid areas, usually receive high water input during rainy season but dry up during the prolonged dry season. However, in sandy river beds underlain by impervious layer, subsurface can be available even after the river stop flowing. Therefore, if appropriate technology is applied to increase storage it can be an important contributor to abatement of water stress associated with drought conditions.
Technology Characteristics	A sand storage dam (or sand dam) is a small dam build on and into the riverbed of a seasonal sandy river. Sand dams effectively increase the volume of groundwater available for abstraction as well as prolonging the period in which groundwater is available. The damming acts by abstracting the flow of groundwater through the riverbed which helps to create additional groundwater storage for the community. The volume of water available for abstraction is considerably larger than just the volume present in the riverbed sands because a large quantity of the water is additionally stored in the riverbanks, recharging the sand dam reservoir in the dry season. The construction of a sand dam involves construction of a reinforced concrete wall (or a similarly robust and impermeable weir) built 1-5 meters high across a seasonal sand river.
Country Specific Applicability & Potential	Many rivers in the arid and semi-arid areas are seasonal, filling during the rainy season and completely drying out during the dry season. The river beds in these regions are usually sandy, which has a large water holding capacity. Construction sand dams will help to hold and store water during the rainy season for use during the dry season. There is large potential for sand dams in the arid and semi-arid regions which constitute the bulk of the land surface in Kenya
Status of Technology in Kenya	Sand dams have been constructed in south eastern regions of Kitui and Machakos mainly by NGOs. These have helped to alleviate water problems associated with prolonged dry seasons in these regions.
Benefits to Economic/Social and Environmental Development	• Availability of water for domestic and livestock during the dry season • As with any good water resource development, since less time is needed to fetch water, so school attendance increases significantly and more time can be spent on other income generating activities. • Women empowerment by providing readily available water and committing time spent looking for water to family and other socio-economic activities • Reduced incidences of water born diseases

Climate Change Adaptation Benefits	Climate change projection for Kenya indicates general rainfall decrease most of the country, which together with population growth is bound to impact serious strains in existing low freshwater endowment in the country. The Arid and Semi-arid areas will be the most affected by the climate change and therefore the sand dams will serve to alleviate the climate change induced water stress in these areas. Sand dams can also contribute greatly to the stabilization of declining groundwater tables (Elliot et al 2011).
Financial Requirements and Costs	The average cost of a sand dam to serve 200 households is estimated at US$ 10,000

ANNEX 1.2: AGRICULTURE SECTOR FACT SHEETS

1. TECHNOLOGY: DRIP IRRIGATION	
Introduction	Irrigation is an agricultural operation, supplying the need of a plant for water. Irrigation is necessary in a dry climate where natural rainfall does not meet plant water requirements during all or part of the year. In Kenya, land and water resources are becoming scarcer and arable land has decreased tremendously due to population increase, unreliable rainfall caused by periodic droughts and lack of appropriate technologies to cope with the situation. Persistent droughts due to climate change have led to persistent threat of household food security and exacerbated poverty in the country. The importance of irrigation and efficient use water due to water scarcity is being addressed through development of more efficient irrigation systems and methods such drip irrigation.
Technology Characteristics	A wide range of components and system design of drip irrigation are available. Drip irrigation zones can be identified based on factors such as topography, field length, soil texture. Drip irrigation provides: • Maximum efficiency in water use • Reliable heavy duty lines and high quality drippers with wide water passage • Easily filled and drained • Enables fertilization through the system • Simple in installation and maintenance • Gravity fed or low-head drip irrigation technologies
Country Specific Applicability and Potential	The agricultural sector in Kenya has continued to be the prime mover of the economy and provides about 55% of Gross Domestic Product (GDP) and about 80% of employment. About 20% of the total area in Kenya may be considered to be of medium –high potential rain-fed agricultural activity. A large proportion of the remaining arable land could be brought into productive use through irrigation. The irrigation potential in Kenya is estimated at between 360,000 and 540,000 ha with an additional 600,000 ha which can be made productive through irrigation. Use of the drip kit is spreading in Kenya and the majority of drip users (some 70-80%) are women. Women do most of the gardening in Kenya.
Benefits to Environmental, Economic/ Social Development	Drip irrigation can help use water efficiently. A well designed drip irrigation system reduces water run-off through deep percolation. It also reduces high water consumption and therefore production of crops is increased. Disease prevalence in drip irrigation is reduced contributing to high crop yields. Drip irrigation increases areas with permanent or seasonal water scarcity since crop varieties to plant can also be adaptable to these conditions. The drip system technology is adaptable to terrains where other systems cannot work well due to climatic or soil conditions. Drip irrigation system can be automated to reduce the requirements for labour.
Climate Change Adaptation Benefits	Drip irrigation technology can support farmers to adapt to climate change by providing efficient use of water supply. In seasonal droughts, drip irrigation reduces demand for water and reduces water evaporation losses by providing the necessary water resources direct to the plant when required.

Financial Requirements and Costs	The initial cost of drip irrigation systems can be higher than other systems. The technologies for drip irrigation are varied and some of them are including use of a plastic bucket are very cheap. The average cost of a drip irrigation is about US $ 250 A $ 15 bucket kit can also irrigate an area of about 15-20 meters square. Cost of installations is also compensated by high yields after the development.

2. DROUGHT TOLERANT SORGHUM	
Introduction	Due to global warming and climate change, the country has been faced with drought hence there has been a shift focus from crops like maize, beans to drought tolerant plants and crops especially in areas where rains are not sufficient. Sorghum is grown in areas with as little as 250mm of rainfall. The drought tolerant sorghum varieties such as Serena, Seredo super sorghum are produced as a result of plant breeding to enhance their resistance or tolerance to stresses that result from climate variability. Drought is a major constraint to rain- fed crop production. Yield losses vary according to severity and type of drought. Prolonged drought at any stage will result into crop failures. To minimize the impact of drought, technologies have been developed by KARI and other Research Institutions to increase chances of successful harvests.
Technology Characteristics	Introduction of drought tolerant sorghum. The capacity of increasing agro – ecosystem to respond to climatic stresses. The technology reduces the risk of total crop failure and provides the producers with chances of dealing with the uncertainty created by climate change because they require relatively little rainfall. The sorghum are less affected by crop pests compared to maize.
Country Specific Applicability	Sorghum crops grow well in semi – arid and arid areas which occupy the great geographical area of Kenya. The ASALs occupy about 80% of Kenya's land mass. Hence the crop is very much applicable to dry areas of the country such as parts of Eastern Province, parts of Rift Valley, parts of Nyanza and Western.
Status of the Technology in the Country	The technology has been developed and adopted by farmers in the country. However, the adoption studies have been on and are still on-going. Farmers are already using the drought tolerant varieties in drought prone areas to improve sorghum production under drought conditions. Extension agents and NGOs are promoting drought tolerant sorghum for food security and beer brewing.
Benefits to Economic/Social and Environmental Development	The sorghum flour can replace maize flour in making ugali. They have high nutritional value because when processed and packaged, they do not loose their nutrients very fast. Trials are on for forage sorghum variety that is capable of multiple cutting for over 3 yeas. Sorghum is Africa's oldest food crop. It is full of energy – giving nutrients. The direct and indirect benefits of drought tolerant sorghum Includes the following: water use efficiency improved; expands arable land; reduce soil erosion, improvement of soil fertility and improvement in food security.
Climate Change Adaptation Benefits	Sorghum requires relatively little rainfall. Sorghum is not affected by pests as much as other cereals such as maize. Sorghum grows well in arid and semi arid areas. Sorghum is not only drought tolerant but it is also adaptable to most of Kenya's climatic zones and soils.
Financial Requirements and Costs	US $ 115. The costs relate to the adoption of the drought tolerant seeds by farmers but does not include the research and development of the drought tolerant sorghum variety by KARI which is estimated to cost about Kshs 3 million over a period of 7 years or so.

3. CONSERVATION TILLAGE	
Introduction	This is a system of land preparation using a ripper where only planting holes/farrows (ripping) are made whilst the land remains unploughed. Hand hoes or folk jembes can also be used where only planting holes are made (pitting) whilst the rest of the land remains unploughed. A farmer can also intercrop maize/green manure cover crops and after harvest crop residues left on the farm. This system is based on minimal soil disturbance (reduced or no tillage).It is a method of growing crops without disturbing the soil through ploughing
Technology Characteristics	This technology embraces soil erosion control. Moisture conservation and soil fertility improvement through combining conservation tillage (ripping) for planting holes/farrows with possibility of intercropping maize/green manure cover crops. The technology is being promoted in Kisii and KARI Station in Marsabit.
Country Specific Applicability	The technology has been adopted in Kisii, Nyando, Transmara, Nandi and Marsabit Districts.
Status of the Technology in the Country	It was developed in 2005.Farmers are practicing it in the areas mentioned above.
Benefits to Economic/Social and Environmental Development	Conservation tillage reduces fuel consumption and soil compaction reduced since no tractor travels over the field. Farmers make savings in fuel and labour to create more time for additional farm work or off-farm activities for livelihood diversion. Application of Herbicides and fertilizers can be reduced
Climate Change Adaptation Benefits	Conservation tillage reduces erosion, improves soil structure and soil-water dynamics. The cover crops used in conservation tillage are usually leguminous which are typically high in nitrogen. Improved soil nutrient recycling may also help control crop pests and diseases
Financial Requirements and Costs	US $ 12.5. The costs here cover the tools and implements used in Conservation Tillage.

4. BIOTECHNOLOGY- TISSUE CULTURE BANANA	
Introduction	Biotechnology involves breeding for improved performance under environmental stresses. Biological activities do attribute to crop adaptation to climate change. Biotechnology works towards producing plants and crops that resist pests and disease damage in a number of crops. Biotechnology also addresses the issue of high yielding and early maturing crop varieties. Biotechnology also helps researchers to develop more nutritious strains of staple crops.
Technology Characteristics	Biotechnology works through transferring genes from other plant lines into the crop of interest. Superior genes can be transferred from one plant organism to another. The technology has been used in such crops as Tissue banana Culture, rice, maize and sorghum, potato soya. There have been impressive successes in terms of improved yields, pest and disease resistance with Genetically Modified organisms (GMOs) or crops.

Country Specific Applicability	The technology is currently being used in the country. For example tissue culture Banana techniques have been adapted widely in Kisii, Meru and parts of Central Province e.g Thika .Tissue Culture planting materials are found to do better than the suckers with an increased higher yield about 4 to 5 times. The cultivars used in Tissue Culture Bananas include but not limited to the following : Cavendish Group(Chinese Cavendish, Giant Carvendish, Grand Nein); Williams hybrid, Gold finger, Lacatan, Valgy and Paz.
Status of the Technology in the Country	The technology is existing . It has been piloted, tested, being disseminated and is commercially available for some crops such as bananas, maize, soya beans, cowpeas, rice, cowpeas and beans. There is even a Bio-safety Authority already established in Kenya.
Benefits to Economic/Social and Environmental Development	The molecular breeding tools used in Biotechnology have resulted into a 3 to 5 fold increase in yields e.g in maize and banana. Biotechnology has assisted farmers to address the impacts of climate change in the agricultural sector, especially the harmful effects of climate change. Leading research scientists are now calling for genetically modified crops to be extended to the people in the developing world. Some research findings in KARI do indicate that biotechnology besides contributing to higher crops yields, disease and pest resistance also has some direct bearing on improved environmental conservation. Biotechnology helps farmers to produce more nutritious crops while sustaining continued farming , Biotechnology continues to make a positive contribution in alleviating world hunger and increase agricultural productivity leading to national and global food and nutritional security in an environmentally sustainable manner. Biotechnology can be used to increase food production in the face of diminishing land and water resources.
Climate Change Adaptation Benefits	Biotechnology has led to the development of genetically modified crops that have adaptive capacities in vulnerable climatic conditions especially in drought and salt tolerance. Some of the biotechnology products showing longer- term promise for adaptation to climate change include the following: • Drought tolerant maize • Drought tolerant rice • Drought tolerant tobacco • Salt tolerant rice
Financial Requirements and Costs	US $ 232.5. The costs relate to the adoption of the technology by farmers in production of tissue culture banana excluding the cost of the research and developing of the cultivars.

5. HAY PRESERVATION	
Introduction	Hay making is the process of turning green, perishable forage into a product that can be safely stored and easily transported without danger of spoilage while keeping the nutrient loss to a minimum. Hay making is one of the best ways to increase the year-round carrying capacity of the farm as forage is harvested during the periods of rapid, excess growth and undamaged by weather. In dry areas, it is relatively easier to make hay compared to other forage. Due to hay making, livestock farmers can feed cattle and other animals for 365 days. The purpose of hay making is to conserve excess forage during rainy season for use during the dry season when forage is scarce and secondly, to produce a cost effective, nutritive livestock feed. It is easier to make hay in dry areas such as Eastern, North Eastern and parts of Coast Province.
Technology Characteristics	Hay can be made from a number of crops:- Maize, Sorghum, Incerne, Desmodium, Napier grass, Rhodes grass and oats. The process of making hay involves drying the green crop. This involves reducing the moisture content of green forages so that they can be stored without spoilage or further nutrient loss. Hay can be made from any amount of grass. Hay requires heat to dry. So heat in the dry areas is good for hay making. Some of the characteristics include: green in colour; pleasant smell; not easily broken; has more leaves than stem and animals like it. Grasses for fodder should be harvested or cut at the pre-flowering stage because after flowering and seeding, grasses contain less nutrients. Hay can be made from planted or natural pastures. It is usually best at the end of rains when there is plenty of sunshine and plenty of forage.
Country Specific Applicability	The practice of hay making is widespread in the country for both small operators and large scale operators. For small scale operations, the grass is cut with a sickle just before flowing. The cut grass is then spread on the field to dry turning it once a day for 3 days. The dried grass is finally baled using a simple box with dimensions of 3 ft x 11/2ft x 2ft. The box is filled with dry grass then tightly packed and tied with strings on both ends. For large operations, grass is mowed, tedded, raked and baled and stored. In Kenya, KARI Embu Station developed a low cost and farmer friendly hay baling box. The technology has been adopted and is being used by several farmers routinely in the country.
Status of the Technology in the Country	The technology has been adopted and is being used by some livestock farmers in dry areas.

Benefits to Economic/Social and Environmental Development	Hay making is important for dry areas where there are likely to be shortage of forage during the drought. The forage is conserved during the rainy season for use during dry season when forage is scarce. Hay making improves carrying capacity of the farmers. The livestock farmers can feed the livestock through out the year. Feeding hay to livestock helps reduce the amount of concentration feeding and thereby the cost of feeding. The low moisture content of hay considerably reduces the cost.
Climate Change Adaptation Benefits	Hay making is basically a process of storing grass in the form of hay for use during the dry season. Hay making conserves forage during the rainy season for use during the dry season when forage is scarce. Hay can safely be stored and easily transported without danger of spoilage, while keeping nutrient loss to a minimum. Hay making is said to be one of the best ways to increase the year-round carrying capacity of the farm because forage is harvested during periods of rapid, excess growth and then fed during stress periods. The livestock farmers can then feed cattle and other animals for 365 days in a year thus adapting to climate change effects
Financial Requirements and Costs	The technology for hay making is estimated to cost US$650 per hectare. This covers the processes of harvesting (cutting); drying, adding drying agents and reservations; bailing and storage of the hay.

6. EARLY WARNING SYSTEM	
Introduction	• Climate in Kenya is influenced by topographical features and the large water bodies such as Lake Victoria, Indian, Atlantic and PacificOceans. • The country also lies along the Equator and therefore the annual rainfall is influenced by the movement of the Inter- Tropical Convergence Zone (ITCZ) which passes over the country twice annually. • The Sub- Tropical pressure patterns over the Indian and Atlantic Ocean have a strong influence on the seasonal rainfall because they control the movement and strength of the ITCZ. • Indian Ocean is the main source of moisture that provides rain over most of the country • The warming (El- Nino) or cooling (La- Nina) of the Pacific Ocean have influence on the rainfall patterns in the country causing floods in some areas and droughts in others. • Tropical cyclones over the South- Western Indian Ocean have influence on the long rains season because of their Perturbation Circulation Systems. • Sea surface temperatures of the oceans change relatively slowly. Their monitoring is able to provide information that can be used to make assessment of the performance of the seasonal rains in good time for early warning and preparedness. • In order to develop effective information products for early warning the country needs to: a) Establish and strengthen International cooperation in climate data exchange b) Strengthen the climate monitoring systems in the country c) Strengthen Climate information dissemination to the users. The information can be disseminated through innovative ways such as specially

	prepared bulletins and community based radio networks. Some of the intervention options involve undertaking: • Increase the density of surface observation network that will fit into the Global Climate Observing System (GCOS). • Strengthen the network of Automatic weather stations AWS) especially in remote areas. • Establish an effective system for disseminating climate information to the user communities, For Example: Community Radio Networks. • Prepare the information in a way that different communities will understand and be able to use in order to enhance their different socio- economic activities.
Technology Characteristics	The surface conditions are the most straight forward of the essential climate variables to measure for an Early Warning System. Early Warning System is a set of co-ordinated procedures through which information on foreseeable hazards is collected and analysed for predicting possible future occurance of a natural phenomenon such as drought and disasters. Basically there, are two types of Early Warning Systems i.e. centralized systems implemented by national government bodies and a Decentralised community system operated by volunteer at community level. Some of the instruments for gathering climatic data include the following: • A thermometer for measuring air and sea surface temperature • A barometer for measuring barometric pressure/air pressure • A hygrometer for measuring humidity • An anemometer for measuring wind speed • A wind vane for measuring wind direction • A rain gauge for measuring precipitation • A pyranometer for measuring solar radiation Indigenous knowledge through the use of bio-indicators helps farmers to maintain productive farming practices to adapt to longer periods of suitable weather for crop cultivation or crop type selection. Local farmers do observe to enable them take decisions on their agricultural production. Observation of certain bio-indicators for several months to make weather forecasts and predictions to be able to adjust say planting and cultivation activities. In some communities, end of season can be predicted by migration of some birds or organisms or budding of some trees which alert the farmers to prepare the land.
Country Specific applicability and potential	The Early Warning Systems are developed and operational especially by the Kenya Meteorological Department and Ministry of Special Programmes not only for weather forecasts but also disaster preparedness for farmers, pastoralists, and community members especially in Arid and SemiAridLands. Indigenous Knowledge by communities is also very important
Status of Technology in the Country	The technology is very well developed especially in the Kenya Meteorological Department for agricultural information to farmers. The disaster preparedness may not be as fully involved. There is a draft(Disaster Management Policy which caters for all disasters including drought)
Benefits to Economic/Social	A reliable, accurate Early Warning System is very important for the Agricultural Sector to assist farmers and pastoralists take better decisions on agricultural

and Environmental development	operations and activities with the following possible resultant benefits: • Reduction of agricultural losses due to adverse climatic events • Increasing productivity that in some cases can guarantee profits for the producer • Availability of data that can be useful to help the official agricultural planning • Reduction of official budget used to cover the agricultural losses is about USD 150 million per year
Climate Change Adaptation Benefits	Weather data is important for advance information say crop calendar i.e. when to prepare land, when to plant, when to expect to harvest and possible yield levels. The climate Impact on Agriculture and System of Agricultural Impacts of Climate Systems developed by FAO do assist in developing adaptation strategies.
Financial Requirement and Costs	This is estimated at US $ 1000 for a rural weather station. The cost relates to equipment and construction of a station

ANNEX 2: STAKEHOLDER ENGAGEMENT

Annex 2.1: Members of the Project Management Unit (PMU)

No.	Name	Institution	Contact
1.	Prof. Geoffrey Wahungu	Director General , NEMA	dg@nema.go.ke
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10.		Project Accountant	
11.	Margaret Maimba	National Council of Science and Technology	mmaimba@ncst.go.ke
12.	Suresh Patel	Kenya Association of Manufacturers	kridha.kenya@gmail.com; business@kridha.com

Annex 2.2: National Project Steering Committee

No.	Name	Institution	Contact
1.	Representative of Permanent Secretary	Ministry of Local Government	
2.	Representative of Permanent Secretary	Ministry of Water and Irrigation	
3.	Representative of Permanent Secretary	Ministry of Environment and Mineral Resources	
4.	Representative of Permanent Secretary	Ministry of Finance	
5.	Representative of Permanent Secretary	Ministry of Forestry and Wildlife	
6.	Representative of Permanent Secretary	Ministry of Agriculture	
7.	Representative of Permanent Secretary	Ministry of Public Health	
8.	Margaret Maimba	National Council of Science and Technology	mmaimba@ncst.go.ke
9.	Representative	Civil Society	
10.	Suresh Patel	Kenya Association of Manufacturers	kridha.kenya@gmail.com; business@kridha.com

Annex 2.3: Adaptation Consultants

	Name	Institution	Contact
1.	Dr. Peter Njuru	Professional Training Consultants (PTC)	njurupg@yahoo.com
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5.	Mrs. Joyce Onyango	Professional Training Consultants (PTC)	joyonyango@yahoo.com

Annex 2.4: Detailed Lists of Stakeholders

Annex 2.4.1: Government Institution

Institution	Responsibility
1. Ministry of Environment and Mineral Resources	• Policy formulation on environmental conservation and oversight of environmental conservation and management activities.
2. National Environment Management Authority	• Implementation of the environment policy and legislation. • Regulation and co-ordination of environmental conservation and management activities. • Coordination of integrating environment into policy system.
3. Meteorological Department	• Provision of meteorological and climatological services to users.
4. Department of Resources Surveys and Remote Sensing	• Co-ordination of research in meteorology and climatology. • Resource Survey and Mapping
5. Office of the Prime Minister and Ministry of Planning, National Development and Vision 2030	• Co-ordination of National Planning and Development • Co-ordination of Implementation of MDGs & issues of environment poverty and Vision 2030. • National Coordination of matters related to climate change.
6. Kenya National Bureau of Statistics	• Collection, compilation, analysis, publication and dissemination of statistical information & the coordination of the national statistical system, and for connected purposes.
7. Kenya Bureau of Standards	• Development and enforcement of standards
8. Ministry of Forests and Wildlife	• Policy formulation and legislation in the forest and wildlife sectors.
9. Kenya Forest Service	• Implementation of Forest Policy and legislation. • Regulation of the forest sector.
10. Kenya Wildlife Service	• Regulation of the wildlife sector.
11. Kenya Forestry Research Institute	• Research and development in the forest sector. • Promotion of transfer of forest management technologies.
12. Ministry of Agriculture	• Policy formulation and legislation in the Agriculture Sector. • Promotion of sustainable Agricultural Production
13. Kenya Agricultural Research Institute (KARI)	• Research and development in the agriculture and livestock sectors. • Promotion and transfer of agricultural technologies.
14. Kenya Industrial Research and Development Institute (KIRDI)	• Research and development and Technology transfer • Promotion and transfer of industrial technologies.
15. Ministry of Finance	• Responsible for all taxes including incentives and disincentives for environmental management.
16. Kenya Revenue Authority	• Fiscal Policy formulation and legislation • Budgetary allocations
17. Ministry of Health	• Policy formulation and legislation • Public Health
18. Ministry of Local Government	• Policy formulation and legislation
19. Ministry of Fisheries	• Policy Formulation, Legislation Development, Training and Extension Services on Marine and Fisheries
20. Ministry of Tourism	• Responsible for all tourism and related activities.
21. Ministry of Water and Irrigation	• Policy Formulation, Legislation in the water sector
22. Ministry of Livestock Development	• Policy Formulation, Legislation Development, Training and Extension Services
23. Kenya Marine and Fisheries Research Institute (KMFRI)	• Research on Fisheries and transfer of technology
24. Ministry of State for the Development of Northern Kenya and other Arid Lands	• Policy formulation, legislation, development and transfer of technology in ASALS
25. National Disaster Management	• Disaster Policy and Development of disaster preparedness and

Authority	intervention
26. Kenya Tea Development Agency (KTDA)	• Development, processing and marketing of tea
27. Tea Research Institute (TRI)	• Tea Research and Transfer of Technology
28. National Irrigation Board (NIB)	• Irrigation development and technology transfer
29. Kenya Plant and Health Inspection Services (KEPHIS)	• Control of importation and exportation of plants and plant species
30. Ministry of Housing	• Implementation of Housing Policy
31. City Council of NRB	• Implementation of Housing Policy in Nairobi
32. National Housing Corporation	• Development and management of urban housing
33. Ministry of Public Health & Sanitation	• Policy formulation and legislation in the health sector
34. Kenya Medical Research Institute (KEMRI)	• Responsible for carrying out health research in Kenya
35. Water Resources Management Authority (WRMA)	• Water apportionment and allocation; catchment protection and conservation,; water resources management
36. Water Services Board	• Planning and developing water supplies and sewerage services

Annex 2.4.2: Private and Public Industries and Associations

Institution	Responsibility
1. Unilever Tea Kenya Ltd.	• Promotes renewable energy in its tea factories.
2. IGAD Climate Prediction and Application Centre	• Undertakes capacity building in the area of climate change.
3. World Agro-forestry Centre / ICRAF	• Undertake research in climate change technologies.
4. Federation of Kenya Employers	• Undertakes research in climate change technologies.
5. Nairobi Hospital Aga Khan Hospital	• Management of hospital and wastes.

Annex 2.4.3: Technology Suppliers and Distributors

Institution	Responsibility
1. Harvest Africa	• Agricultural technological development and dissemination
2. Biotechnology Foundation	• Technological development and dissemination
3. Kenya Organic Agriculture and Environmental Technologies Institute	• Development and dissemination of technologies
4. Africa Centre for Technology Studies (ACTS)	• Development and dissemination of technologies
5. Kenya Planters Cooperative Union	• Coffee processing and dissemination of technological information
6. Kenya Meteorological Society	• Data and information

Annex 2.4.4: Finance and Investment Community (Development Partners)

Institution	Responsibility
1. World Bank	• Financing of climate change projects. • Deals with carbon fund.
2.International Finance Corporation (IFC)	• Investment in climate change technology development and transfer.
3. Germany Technical Co-operation (GTZ)	• Investment in climate change technology development and transfer.
4. African Development Bank (AFDB)	• Finances strategy that mitigates climate change.
5. Canadian International Development Agency (CIDA)	• Promotes climate change related programmes.
6. UNEP	• Finance technology transfer and capacity building.
7. UNDP	• Finance capacity building, technology development and transfer.
8. GEF being implemented by UNEP, UNDP & World Bank	• Finances capacity building and technology development and transfer in climate change.
9. EU – European Union	• Finances capacity building activities, technology transfer and development.
10. JICA – Japanese International Co-operation Agency	• Supports and finances climate change activities
11. SIDA – Swedish International Development Agency	• Finances capacity building activities in Climate change

Annex 2.4.5: Support Institutions

Institutions	Responsibility
1. Department of Meteorology, University of Nairobi	• Capacity building in climate change adaptation and mitigation. • Research and Development in climate change.
2. Moi University School of Natural Resources Management	• Capacity building in forestry and wildlife conservation and management. • Research and development in the forestry and wildlife sectors.
3. Kenya Institute of Policy Research and Analysis (KIPRA)	• Promotes research in climate change. • Promotes research in economic instruments.
4. Intermediate Technologies Development Group (ITDG - EA)	• Development and promotion of renewable energy technologies
5. Professional Training Consultants (PTC)	• Consultant services on climate change.
6. National Climate change Activities Co-ordination Committee	• Co-ordination of national climate change activities
7. District Environmental Committees	• Coordination of environmental issues at grassroot level
8. County Environmental Committees	• Coordination of environmental issues at county level

Annex 2.4.6: International Organizations

1. United Nations Environment Programme – UNEP	• Promotes technology development and transfer capacity building in climate change.
2. United Nations Development Programme (UNDP)	• Promotes research in climate change.
3. World Meteorological Organization (WMO)	• Promotes research in climate change.
4. United Nations Framework Convention on Climate Change (UNFCC)	• Promotes climate change adaptation and mitigation.
5. World Agro Forestry Center (ICRAF)	• Promotes Research and Development in Agro forestry
6. United Nations Industrial Development Organization	• Promotes technology development and transfer; capacity building in climate change.
7. Food and Agriculture Organization of the United Nations (FAO)	• Operates a climate change programme which seeks to strength countries capacity to mitigate and adapt to climate change.

Annex 2.5: Members of TNA Adaptation Sector Working Group

No.	Name	Institution	Contact
1.	Soul Kasha	Ministry of Planning National Development & Vision 2030	sksoulkasha@gmail.com
2.	Paul M. Nguru	NEMA	ngurupg@yahoo.com
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6.	Onyango Desmond J.	Office of the Prime Minister	desjunior77@gmail.com
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9.	Esther Magambo	Ministry of Agriculture, Coordinator, Climate Change Unit	
10.	Julliet Adhiambo	NEMA	julietmn@yahoo.com
11.	Violet O. Kirigwa	Kenya Agricultural Research Institute	
12.	Prof. Shem Wandiga	Institute of Climate Change Adaptation, University of Nairobi	
13.	Eric kisiangani	Practical Action	Eric.kisiangani@practicalaction.or.ke

Annex 2.6: List of Participants for Stakeholders Workshop

Annex 2.6.1: List of Stakeholders who Attended Inception Workshop held on 11th June 2011 at KICC Nairobi, Kenya

	Name	Organization	Address	Email
1	Dr. Ayub Macharia	NEMA	Box 67839 – 00200 Nairobi	
2	Mr. David Cheruiyot	NEMA	Box 67839 – 00200 Nairobi	
3	Mr. Louis Gachimbi	NEMA	Box 67839 – 00200 Nairobi	igachimbi@nema.go.ke
4	Mr. Maurice Otieno	NEMA	Box 67839 – 00200 Nairobi	mnyunja@nema.go.ke
5	Dr. Ann Omambia	NEMA	Box 67839 – 00200 Nairobi	
6	Mr. Patrick Maingi	NEMA	Box 67839 – 00200 Nairobi	pmaingi@nema.go.ke
7	Mr. Godfrey Mwangi	NEMA	Box 67839 – 00200 Nairobi	gmwangi@nema.go.ke
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9	Ms. Jane Kibwage	Min. of Fisheries	Box 34188 -	jmkibwage@gmail.com
10	Mr. Paul Nguru	NEMA	Box 67839 – 00200 Nairobi	
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17	Mathew Lekapina	NEMA	Box 67839 – 00200 Nairobi	
18	Lucy Nduta	NEMA	Box 67839 – 00200 Nairobi	
19	Gabriel Vincent Sanya	NEMA	Box 67839 – 00200 Nairobi	gsanya@nema.go.ke
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	Name	Organization	Address	Email
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29	Issack Elmi	NEMA	Box 67839 – 00200 Nairobi	ielmi@nema.go.ke
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32	Maurice Odengo	KNA		modenngo@yahoo.com
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37	Joseph Mbugua	KFS		Josembugua06@yahoo.com
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43	Joseph M. Mutie	PTC		josemutie@hotmail.com
44	Peter Mwangi	KWS		pnjiiri@kes.go.ke
45	Brendah N. Kibulo	KNA		b.kiboi@yahoo.com
46	Meshack Omari	NEMA		hmomari@nema.go.ke
47	Vincent Matioli	Min. Of Special Programmes		matioli@sprogrammes.go.ke
48	Okioma .N. Chrisantos	MPND V2030		cokioma@planning.go.ke
49	Florian Zerzany	ATMOSTAIR		zerzny@atmostair.de
50	Gideon Chikamai	Min. Of Transport		gchikimai@gmail.com
51	Susan W. Karanja	KNA		susanwanjiku09@gmail.com
52	Eric Kisiangani	Practical Action		eric.kisiagani@practicalaction.or.ke
53	George Okore	Times Africa Press		getsaid@gmail.com
54	Olive Muthoni	KENGEN		omuthoni@kengen.or.ke

Annex 2.6.2: List of Stakeholders who attended Sector and Technology Prioritization Workshop (2nd Stakeholders Workshop – 22nd February, 2012 at NEMA Boardroom)

	INSTITUTION	CONTACT PERSON
1.	Ministry of Agriculture	Nelson Gatonye
2.	Ministry of Livestock Development	Joseph Kamande
3.	Kenya Forestry Research Institute	Dr. Vincent Oeba
4.	Kenya Forestry Service	Alfred Gichu
5.	Kenya Forestry Working Group	Rudolf Makhanu
6.	KENGEN	Pius Kolikho
7.	KIRDI	Mr. Aduda Kenneth
8.	Ministry of Energy	Director of Renewable Energy
9.	Kenya Association of Manufacturers	Mr. Suresh Patel
10.	Mumias Sugar Company Ltd	Johnah Omuyoma Director of Factory
11.	Nuclear Electricity Company	Winnie Ndubai
12.	Ministry of Industrialization	Julius Kithinji Kirima- Assistant Director-Industrial Information and Research
13.	Ministry of Planning National Development and Vision 2030	Attn Joseph Mukui
14.	Climate Network Africa	Grace Akumu
15.	Nairobi City Council	Anthony Waweru Urban Planning, Environmentalist
16.	Ministry of Housing	
17.	Ministry of Transport	
18.	Kenya Railways	
19.	Ministry of Water and Irrigation	Hydrology Dept. and Irrigation dept
20.	Ministry of Public Health and Sanitation	
21.	Athi Mining Company	Humphrey Mwamburi
22.	Ministry of Environment and Mineral Resources	Att.n Eng. Omedi Climate Change Secretariat
23.	KARI	Violet O. Kirigwa
24.	Ministry of Education Science and Technology	Department of Research
25.	Office of The Prime Minister, Climate Change Coordinating Office	Patrick Chabeda

Annex 2.6.3: List of Participants who Attended the 3rd Stakeholders Workshop held on Wednesday 25th, July 2012

No.	Name	Organization	Mobile No.	E-mail Address
1.	Dr. Zablone Owiti	NCST	0721790204	zowiti@ncst.go.ke
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6.	John Nganga	PTC	0722524430	jknganga@uonbi.ac.ke
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14.	Mary Mugo	OPM	0711345726	marymugo28@yahoo.com
15.	Mary Onyango	OPM	0720767831	monyango2@yahoo.com
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19.	Elizabeth Maweu	OPM	0735635185	emaweu@gmail.com
20.	Patrick Macharia	KNCPC	0722403153	pahmacharia@yahoo.com
21.	Christine Mutua	KMSF	0727997390	cmutua@yahoo.com
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25.	Peter Njuru	PTC	0724147913	njurupg@yahoo.com
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27.	Onyango Desmond .J.	OPM	0728409139	desjunior77@gmail.com
28.	Evans Nangulu	KNCPC	0720530682	enangulu@cpkenya.org
29.	Stephen M. King'uyu	MEMR/CCS	0726769545	king_uyu@yahoo.com
30.	Eng. Omedi Moses Jura	MEMR/CCS	0722688752	omedimosj@yahoo.co.ke
31.	Juliet Adhiambo	NEMA	0722254734	julietmn@yahoo.com

Annex 2.7: TNA Questionnaire used in Sector and Technology Prioritization

TECHNOLOGY NEEDS ASSESSMENT (TNA) FOR CLIMATE CHANGE MITIGATION AND ADAPTATION - INFORMATION COLLECTION INSTRUMENT

Name of Institution/Organization……...

Address: ……..

Name of Respondent (Optional):…….....

Position (Optional)……..……

Date: ……..

PREAMBLE

Climate Change is a global phenomenon that affects all countries in different ways depending on prevailing national circumstances. Scientific evidence that climate change has potential to cause serious adverse impacts at global and local levels led to formulation of United Nations Framework Conventions on Climate Change (UNFCCC) in 1992. Article 4 of the Convention outlines the major commitments of the Country Parties to respond to climate change including to formulate national and regional programs containing measures to mitigate climate change by addressing sources and sinks of greenhouse gases, to prepare for adaptation to the impacts of climate change and to promote and cooperate in the development and transfer of technologies, practices and processes that address greenhouse gas sources and sinks. Article 4.5 commits developed Country Parties to assist developing country parties in development, transfer and access of technologies to mitigate and adapt to climate change.

Professional Training Consultants (PTC), on behalf of the National Environmental Management Authority (NEMA), are undertaking a project to assist identify and analyse national priority technology needs for climate change which will form the basis for a portfolio of Environmentally Sound Technology (EST) projects and programs to facilitate the transfer of, and access to, ESTs and know how in the implementation of Article 4.5 of the UNFCCC. Your organization/institution has been identified to provide data and information in this area.

Please note that your answers will be kept confidential and used for this study only.

GUIDING QUESTIONS (Use separate papers if necessary)

1. National development plans and programmes

i) *What is your organization's/institution's mandate?*

……
……
……

ii) Does your organization/institution have strategic plan? Yes/No

iii) If yes what broad areas does the plan cover?

……
……
……
……*Do you have programs and plans that address climate change? Yes/No*

iv) *If yes in what ways (please provide any relevant documents)*

……
……
……
……

2. Contribution of the sector to national socio-economic development:

Please list ways that your sector/organization contributes to national economic and social development?

……
……
……
……

i) *Please list ways in which your sector is related to other sectors/organizations?*

……
……
……
……
……

3. Activities to mitigate and adapt to climate change

i) In your opinion do you think climate change has/will affect your activities? If yes, in what aspects (positive and/or negative)?

……
……
……
……
……

How do your activities contribute to climate change?

……
……
……
……
……

ii) *How do you (or intend to) address climate change adaptation (these are activities that help to lessen the impacts of climatechange)*

……
……
……
……

iii) *How do you (or intend to) address climate change mitigation (these are activities that are geared towards reducing greenhouse gas emissions and increase carbon sink)*

……
……

……
……

iv) *Please list opportunities that exist in your organization for climate change adaptation (Funding, income generation, improved efficiency and savings, etc)?*

……
……
……
……

v) *Please list opportunities that exist in your organization for climate change mitigation (Funding, income generation, improved efficiency and savings, etc)?*

……
……
……
……

4. Sector prioritisation (Adaptation)

Rank the following sectors based on contribution to national development priorities, sensitivity to impact of climate change and opportunities for climate change adaptation

i) Water Resources
ii) Health and Safety
iii) Agriculture
iv) Forestry and land use
v) Marine and Coastal zones
vi) Others

5. Sector prioritisation (Mitigation)

Rank the following sectors based on contribution to national development priorities and opportunities for climate change mitigation

i) Energy
ii) Industry
iii) Transport
iv) Waste
v) Forestry and land use
vi) Agriculture
vii) Others

6. Technology identification for Climate Change Adaptation

List FIVE technologies in your sector(s) in order of importance, based on national development priorities and contribution to climate change adaptation

i)
ii)
iii)
iv)
v)

7. Technology identification for Climate Change Mitigation

List FIVE technologies in your sector(s) in order of importance, based on national development priorities and contribution to climate change mitigation

i)
ii)
iii)
iv)
v)

8. Comments

Please give comments if any on the issues covered above

……
……
…………………………………………………………………………………………………

Name of Interviewer:
……………………………………………………………………………..…

Annex 2.8: List of Stakeholders Who Completed the Questionnaires

The institutions which were served with TNA questionnaires and positively responded by completing the same included the following:

Names	Organization	Dates	Topics
1. Grace Akumu	Climate Network Africa	January 2012	Energy/ Industry
2. Mr. Kithinji Kirima	Ministry of Industrialization	January 2012	"
3. Mr. Humphrey Mwambari		January 2012	"
4. Mr. Jonah Omuyoma	Mumias Sugar Company	January 2012	"
5. Ms. Winfred Njiraini	Nuclear Energy Project	January 2012	"
6. Dr. Samuel Marigi and Ayub Shaka	Kenya Meteorological Department	January 2012	"
7. No Name	ICPAC	January 2012	"
8. No Name	Kenya National Cleaner Production centre (KNCPC)	January 2012	"
9. Pius Kollikho	Kengen	January 2012	"
10. No Name	Ministry of Transport	January 2012	Transport
11. Anthony Waweru	City Council of Nairobi	January 2012	"
12. Walter B. Nyatwanga	Kenya National Highways Authority	January 2012	"
13. No Name	Kenya Railways	January 2012	"
14. Eng. Francis Gitau	Roads Department/ MOR	January 2012	"
15. Mr. Gideon Gathaara	Ministry of Forestry and Wildlife(Headquarters)	January 2012	Forestry and Land Use
16. Mr. Hewson Kabugi	Ministry of Forestry and Wildlife(Headquarters)	January 2012	"
17. Dr. Vincent Oeba	Forestry Research Institute	January 2012	"
18. Mr. Alfred Gichu	Kenya Forestry Service	January 2012	"
19. Mr. Rudolf Makhanu	Kenya Forestry Working Group	January 2012	"
20. Gatonye N.N	Ministry of Agriculture- Climate Change	January 2012	Agriculture, Livestock and Fisheries
21. J.N Kamande	Ministry of Livestock Development	January 2012	Agriculture
22. Simon M. Maitha	Agricultural Finance Corporation	January 2012	Agriculture
23. Jane M. Kibwage	Ministry of Fisheries	January 2012	Agriculture
24. No Name	City Council of Nairobi	January 2012	Water, Health and Safety
25. Lawrence Thooko	WRMA	January 2012	"
26. Eng Omedi Moses Jura	MEMR- Climate Change Secretariat	January 2012	Cross Cutting Issues
27. Productive Sector Division	Kenya Institute of Public Policy Research and Analysis(KIPPRA)	January 2012	"
28. Patrick A. Chabeda	Office of the Prime Minister	January 2012	"
29. Peter O. Odhengo	Office of the Prime Minister	January 2012	"
30. Eunice Boruru	University of Nairobi	January 2012	"
31. John Nyangena	Ministry of Planning National Development	January 2012	"
32. Grace Akumu	Climate Network Africa	January 2012	"

Annex 3.1: Working Groups Report
Group one: agriculture and livestock and fisheries

1 Key sectors identified

- Agriculture
- Livestock
- Fisheries

2 Contribution to National Development

- GDP 27%
- Foreign exchange
- Employment-7%
- Food security
- Poverty reduction
- Infrastructure development – technology

3. Relationship to climate change adaptation and mitigation

- Agro-forestry
- Conservation agriculture

KEY STAKEHOLDERS

- Agriculture
- Livestock
- Fisheries
- Land
- NGOs
- Development partners
- Financial sectors
- Banks
- Private sectors
- Parastatlals (research institutions, universities)

TECHNOLOGIES FOR CLIMATE CHANGE MITIGATION AND ADAPTATION
Hard

- Crop and animal breeding- drought resistant, disease resistant
- Biogas technology
- Agro-forestry
- Value addition
- Preservation technology
- Water harvesting and irrigation
- Conservation agriculture

Soft

- Capacity building – training
- Modeling and early warning systems
- Weather forecast
- Disease surveillance – livestock
- Plant disease and pest control

OPPORTUNITIES FOR TECHNOLOGY DEVELOPMENT/TRANSFER

- Policy and legislations
- Indigenous knowledge
- Creativity and innovations
- Information advancement –ICT
- Development partners

BARRIERS

- Weak policy implementation and enforcement
- Cultural barriers
- Inadequate/lack of technological know how
- High cost of technology transfer
- Inadequate information dissemination
- Market barriers – poor infrastructure, transport,

PRIORITIZED TECHNOLOGIES

Hard

1. Crop and animal breeding- drought resistant, disease resistant
2. Water harvesting and irrigation
3. Conservation agriculture
4. Biogas technology
5. Agro-forestry
6. Value addition
7. Preservation technology

PROJECT IDEAS

- Adoption of multipurpose tree crops
- Water harvesting technologies
- Explore on alternative sources of fuel
- Climate change education/awareness at all levels
- Alternative sources of livelihoods
- Income generating activities

GROUP TWO: Forestry, Wildlife, and Tourism

Key sectors

Forestry, Wildlife, Tourism, Energy, Transport, Agriculture, Water, Construction, Manufacturing and Industry, Health, Planning and Development, Finance

1) FORESTRY

i) Contribution to GDP – about 2%
ii) Contribution to both direct and indirect employment
iii) 70% of energy requirements
iv) Act as water towers
v) Habitat for wildlife
vi) Store for biodiversity

State its contribution…

i) Act as carbon sink
ii) Moderates the micro climate
iii) Protect against soil erosion
iv) Helps retain rain water and prevents run off

Impact of climate change on forests

i) Prolonged droughts leading to extensive forest fires and forest degradation
ii) Explosion of pests and diseases as a result of extreme weather conditions

Key stakeholders

i) Ministry of Forestry and Wildlife
ii) KFS
iii) KEFRI
iv) KWS
v) NEMA
vi) NGOs – FAN, KFWG
vii) Government – local administration, legislature
viii) International partners i.e. ICRAF, WWF, UNEP, UNDP, IFAD, WORLD Bank etc
ix) Communities – CFAs, CBOs, opinion leaders
x) Private sector – timber industry
xi) Researchers and universities

Hard and soft technologies

i) Agroforestry – hard
ii) Afforestation and reafforestation
iii) Efficient utilisation of forest products through use of improved technologies i.e. energy saving *jikos* and high recovery forest conversation equipment
iv) Use of alternative technologies e.g. solar
v) Policies i.e. forest policy, Environment Policy, Climate Change bill, Forest Act

Opportunities for technology

i) Enabling policy and legislative framework
ii) Institutional framework
iii) Locally available technical capacity
iv) Plenty of land and manpower for afforestation

Barriers

i) Scarce financial resources
ii) Land tenure not streamlined
iii) Limited accessibility to these technologies

Project ideas

i) Afforestation, reafforestation and agroforestry
ii) Technology improvement

WILDLIFE

Contribution

i) 30 pc of tourism revenues
ii) Source of employment

Impact

i) Loss of biodiversity
ii) Decline in population

Key stakeholders

i) Ministry of Forestry and Wildlife
ii) KFS
iii) KEFRI
iv) KWS
v) NEMA
vi) NGOs – FAN, KFWG
vii) Government – Counties, administration, legislature
viii) International partners i.e. ICRAF, WWF, UNEP, UNDP, IFAD, WORLD Bank etc
ix) Communities – CFAs, CBOs, opinion leaders
x) Private sector – timber industry
xi) Researchers and universities

Hard and soft technologies

i) Agroforestry – hard
ii) Afforestation and reafforestation
iii) Efficient utilisation of forest products through use of improved technologies i.e. energy saving *jikos* and high recovery forest conversation equipment
iv) Use of alternative technologies e.g. solar
v) Policies i.e. forest policy, Environment Policy, Climate Change bill, Forest Act
vi) Translocation
vii) Cropping
viii) Establishment of corridors and sanctuaries

Opportunities

See above

Barriers

Related to forestry sector

Working group three: Human settlements, construction and waste management

Question 1: List key sectors for climate adaptation and mitigation

Energy

Transport, industry, Agriculture and livestock, Forestry wildlife, tourism, human settlements (including construction and waste management), water resources, health and sanitation, marine and coastal zone

Policy formulation, planning.

State its contribution to national development

Sector	Contribution to national development	Relation ship to climate change	Key stakeholders
Human settlements (Urban)	Employment, industrial growth, Centres of development -source of pollution to air, water, Construction, change of land use	-Disasters (floods, landslides) High demand for energy, production of green house gasses, rise in temperatures, Construction -depletion of natural resources, Poor waste management thus pollution (water, air, soils)	GOK Ministries and Departments -Min of housing -Local Authorities -Lands -Special programmes NGOS, CBOs, Private sector (building industry) and the local people
rural	Food security, (agriculture, livestock), employment, conservation Culture, expanding infrastructure, indigenous technologies, -clearing/expansion to forest for agriculture, use woodfuel contributing to pollution,	Depletion of carbon sinks, low adaptation rates due to low literacy and poverty Disasters- drought, floods, landslides	
Energy	Energy for consumption, production, income,		

Technologies for climate change mitigation and adaptation
Hard technologies – green energies, non motorised transport, pooling of transport, solar for heating, lighting, CFC free cooling systems,

Soft technology- Economic model T 21, creating incentives, policy framework, capacity building to understand inter-linkages of sectors

Barriers
- Accessibility costing,
- out dated policies and laws (for bids water harvesting in urban areas)
- low literacy and poverty
- Taxation
- Lack of coordination leading to duplication
- Low funding
- Low inter sectoral linkages

Opportunities
- Solar
- land, tree planting
- Geothermal
- Existing research institutions
- Designs for buildings
- Enforcement of existing policies
- The new constitution

International level

- Carbon trading
- Donor goodwill for partnership
- Source of funding

Priority of technologies in human settlement
- Green building
- Harmonization of policies
- Project ideas targeting human settlements on climate change adaptation and mitigation
- Establishment of Resource centres
- Establishment of Green points

WORKING GROUP 4: Water Resources, Health & Sanitation, Marine and Coastal Zone

The group consisted of individuals from NEMA, National museums of Kenya, Ministry for Environment and Mineral Resources, and Kenya Bureau of Standards. The group started by agreeing on the general approach to be used in discussing the three assigned areas: Water Resources, Health & Sanitation, Marine and Coastal Zone. The group observed that the three areas should each be considered as distinct sectors and were therefore discussed separately following the provided discussion questions.

Water Resources Sector

The group observed that water resources played an important role in development in agriculture, livestock, energy, industrial and food security, health and sanitation. The link of water resources sector to climate change adaptation and mitigation was noted since climate change will impact on both water quantity and quality and there is therefore need to adapt in order to reduce our vulnerability. The group identified the key stakeholders to include Water Resources Management Authority (WRMA), Water management boards, National Water and Pipeline Conservation, Water user associations, Water service providers among others.

The identified technologies in use were identified to include groundwater abstraction, efficient waste water treatment technologies, rainwater harvesting and storage systems, catchment restoration and conservation, capacity building, awareness creation, improved policy, legal and institutional framework, and community participation. The opportunities and barriers for technology development and transfer were identified to include the following:

- New constitution
- Vision 2030, National Environment Action Plan (NEAP), State of Environment (SoE), ERA, Millennium Development Goals (MDGs) etc
- Other international conventions and agreement
- Strategic positioning globally
- Inadequate funding
- Poor resources management
- Conflicting policies; duplication of roles and functions

The group suggested the following prioritized technologies:

- Awareness creation
- Groundwater abstraction
- Rainwater harvesting systems
- Strategic water investment

Finally the group identified strategic water harvesting and catchment restoration and conservation as the proposed projects under the water resources sector.

Health and sanitation

The contribution to national development for the Health and Sanitation sector was noted since health and sanitation directly impacts national development by increasing productivity and adaptability. The group observed that the link of Health and Sanitation sector to climate change adaptation and mitigation is the projected increased incidences of diseases and pests due to climate change.

Stakeholders identified included ministry of health and sanitation, health service providers and local authorities. The group identified technologies, hard and soft, in the Health and Sanitation sector to include proper waste disposal and treatment facilities, air pollution control technologies, portable water supply systems, capacity building, awareness creation, improved policy, legal and institutional framework and community participation.

Opportunities for technology development and transfer were identified as the new constitution, Vision 2030, other international conventions and agreement and the country's strategic positioning globally. The barriers to technology development and transfer were identified to include inadequate funding, poor resources management, conflicting policies; duplication of roles and functions.

The group proposed prioritised technologies which included strategic investment in waste management facilities to qualify as CDM and REDD projects and investment in healthcare facilities and implementation of strategic

investment in waste management facilities to qualify as CDM and REDD projects and investment in healthcare facilities.

3. Marine and Coastal zone

The group observed that coastal zone are world heritage sites and important tourist attraction sites and also contribute to national development through fisheries, transport, security and food security. The link of marine and coastal zones to climate change was observed to be related to the fact that temperature change will result in sea level rise and coastal land inundation.

The identified key stakeholders were:

- Ministry of Environment and Mineral Resources,
- Kenya Marine and Fisheries Research Institute,
- Ministry of Fisheries,
- National Museum of Kenya,
- Kenya Wildlife Service,
- National Environmental Management Authority
- Kenya Meteorological Department

The group identified the early warning system, restoration and conservation of mangrove forests, vulnerability risk assessment, and disaster preparedness and management as the main technologies in coastal and marine zones sector.

The opportunities and barriers to technology transfer and development were identified as follows:

- New constitution
- Vision 2030, National Environment Action Plan (NEAP), State of Environment (SoE), ERA, Millennium Development Goals (MDGs) etc
- Other international conventions and agreement
- Strategic positioning globally
- Inadequate funding
- Poor resources management
- Conflicting policies; duplication of roles and functions

The group proposed restoration of mangroves and improved legal mechanism and representation as prioritized technologies in marine and coastal zone sector

Annex 3.2: Questionnaire Analysis

Questionnaire No	Agriculture	Water Resources	Forestry and Land Use	Health & Safety	Marine and Coastal Zone
1	2	1	3	4	5
2	2	1	4	3	5
3	1	2	3	4	5
4	2	4	3	1	5
5	4	2	1	3	5
6	1	3	2	4	5
7	1	2	4	3	5
8	3	1	2	4	5
9					
10	1	4	3	2	5
11					
12	2	1	5	4	3
13	1	2	5	3	6
14	2	3	1	4	4
15	2	1	3	4	5
16	1	4	2	3	5
17	1	2	4	5	3
18	2	1	4	6	5
19	1	3	2	4	5
20	2	3	1	5	4
21					
22	1	3	2	5	4
23	1	4	2	5	3
24	2	1	3	4	5
25	2	1	3	4	5
26	2	1	4	6	5
27	1	3	3	5	4
28	1	2	3	5	4
29					
30	1	2	4	3	5
31	1	2	3	4	5
32	4	2	1	3	5
33	2	1	3	5	4
34	2	3	1	4	5
35	2	1	3	5	4
36					
Average	**1.7**	**2.1**	**2.8**	**4.0**	**4.6**
Rank	**1**	**2**	**3**	**4**	**5**