Tana River Delta

STRATEGIC ENVIRONMENTAL ASSESSMENT 2014

Produced to support preparation of the
Tana River Delta Land Use Plan

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Tana River Delta Land Use Plan

Ecosystem Alliance
Learning and collaboration for people and biodiversity

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UNITS OF MEASUREMENT

Ha	One Hectare (10,000 square metres)
Km^2	One hundred hectares
M^3/sec	Cubic metre per second (measurement of river flow)

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LIST OF ACRONYMS

^{0}C	Degrees centigrade
Asl	Above sea level
AEZ	Agro-ecological zonation
CBD	Convention on Biological Diversity
CEDAW	Convention on Elimination of all forms of Discrimination against Women
CITES	Convention on International Trade in Endangered Species
CL	Coastal Lowland
cm	centimetre
CSO	Civil Society Organisation
Cumecs	Cubic metres per second
DDC	District Development Committee
DDP	District Development Plan
EIA	Environment Impact Assessment
EIA/EA	Environment Impact Assessment/Environment Audit
EPS	Economic Stimulus Plan
FTE	Full time equivalent
GIS	Geographic Information System
GMP	General Management Plan
HGFD	High Grand Falls Dam
Ha	Hectares
hr.	Hour
IBA	Important Bird Area
IMTC	Inter-Ministerial Technical Committee
IUCN	International Union for Conservation of Nature
Kengen	Kenya Electricity Generating Company
KFS	Kenya Forest Service
Km	Kilometres
Km^2	Kilometres squared
KSh	Kenya Shilling
KWS	Kenya Wildlife Service
L/IL	Lowland/Inner lowland
LAPSSET	Lamu Port-South Sudan-Ethiopia Transport corridor
LH	Lower Highland
LM	Lower Midland zones
lu	Livestock Units
LUP	Land Use Plan
SEA	Strategic Environment Assessment
m^3	Cubic metres
m^3/sec	Cubic metres per second
MDG's	Millennium Development Goals
mm	Millimetres
Mt.	Mount
MEA	Multilateral Environmental Agreement

MESSAGES FROM TANA RIVER COUNTY GOVERNOR

H.E Hussein Dado
Governor, Tana River County

Over the years, the Tana River Delta, which covers a total area of 130,000 ha and falls within Tana River and Lamu Counties has experienced environmental and land use changes majorly due to the rising human population and competition for land, water, pasture and other finite natural resources. The Tana River Delta has huge biodiversity values. It supports diverse species of plants and animals and is of international importance as a key site for water bird conservation. In spite of these values, no serious attempts have been made in the past to address some of the negative land use and environmental changes affecting the Delta. If anything, the declining water flow in Tana River, the effects of the climate change, interests of the multinational companies alongside these local negative changes have threatened the sustainability and the very existence of the Delta.

The County Government of Tana River therefore applauds the efforts aimed at developing a clear framework for decision making on developments within the Delta in form of a Land Use Plan. The County Government supported and continues to support this unique process. I say unique because unlike other plans, the Tana Delta LUP was subjected a Strategic Environmental Assessment [SEA] which essentially is new phenomenon in Kenya and Africa by extension. The SEA report gives us, as leaders of the County government, confidence on the recommendations of the LUP as it integrates environmental considerations into policies, plans and programmes. The SEA report indicates clearly the implications of the LUP on sustainable development by assessing both internal and external factors influencing land use in the Delta. One great contribution of this process to our county Governments is that we now clearly understand the amount of water we need to continuously flow in the Tana River to ensure basic support of life and other processes within the Delta.

As elected leaders, ours is to serve the people and we stand to defend the rights of the people we serve.

MESSAGE FROM LAMU COUNTY GOVERNOR

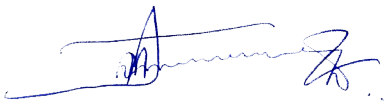
H.E Issa A. Timamy
Governor, Lamu County

In the Kenyan history, it has been difficult and sometimes almost impossible to find middle ground for environmental conservation and development. Tana Delta is a critical habitat both for biodiversity and environmental conservation and also for the huge population residing there. This means that for sustainability, some understanding supported by scientific facts has to be arrived at. To this end, the Tana Delta land Use Plan has been one of the most remarkably developed plans as its development process was entirely subjected to a Strategic Environmental Assessment [SEA]. This, in essence, maximizes sustainable economic development opportunities while also identifying potential impacts of development on human welfare and Natural systems.

As a County Government, we work to promote co-existence among the local communities inhabiting the delta. This however remains a challenge due to the different lifestyles, cultures and livelihood requirements for the inhabitants. We are determined to ensure that our people co-exist peacefully within the Delta as we render them services to the best of our knowledge and ability. This SEA report will be greatly important in harmonizing the different and sometimes conflicting land use forms within the Delta. The report also prepares us as a County Government, moving forward, and in view of the serious infrastructural developments planned for Lamu County such as Lamu Port and South Sudan Ethiopia Transport (LAPSSET) Corridor on the kind of preparedness, projections and adjustments we need to make in order ensure that the needs of our people are attended to even in the times of such developments.

The County Government of Lamu will be at the forefront in engaging other users of the River Tana to ensure that such uses are responsible and take cognizant of the Lamu residents who live at the tail end of the river. We shall also ensure that residents of the lower Tana Delta use the water and other resources responsibly.

In light of this, we shall ensure that we initiate dialogue between us and the National Government alongside the counties upstream of the Tana River, who plan to put up massive developments that will lead to huge water abstractions. The aim of this dialogue will be to ensure that no such developments negatively affect life downstream in the Delta. We shall therefore stand by this SEA report and its findings. We shall also take bold and decisive steps in ensuring a good mix of development activities and conservation of natural resources through creating job opportunities and sustainable economic activities accessible to all.



H.E. Amb. Hussein Dado
Governor, Tana River County

Finally, the County Government of Lamu will promote resource sharing among the various communities in the delta with a view to fostering integration and peaceful co-existence

H.E Issa Timamy
Governor, Lamu County

FOREWORD

The Tana River Delta Strategic Environmental Assessment (SEA) was prepared to support the land use planning process for the Area. The SEA is a result of extensive consultation at community, county and national level with the input of international SEA experts.

The core area of the Tana River Delta comprises land within Tana River and Lamu Counties. The Tana River Delta is a vast patchwork of palm savanna, seasonally flooded grassland, forest fragments, lakes, marine wetlands and the river itself. This combination of habitats makes the Tana Delta a biodiversity hotspot. It is designated as a Ramsar site – a wetland of international importance – and an Important Bird and Biodiversity Area.

The Delta is sparsely populated and inhabited by three major communities comprising Pokomo farmers, Orma pastoralists and Wardei pastoralists. Other ethnic groups include the Bajuni, Luo, Luhya, Boni, Wataa/Sanye, Malakote and Munyoyaya, among others. Large and small scale irrigation farming takes place in the Tana Delta. Large herds of cattle graze in the Delta during the dry season. In addition, a number of projects within Kenya's Vision 2030 are planned within the Delta and its catchment.

Over the past decade, conflicts have been increasing in the Tana River Delta as a result of increasing population, competition for land, land-based resources and access to water, and encroachment into fragile ecosystems. These conflicts are compounded by lack of a general framework to guide decision-making on development of the Delta. This has compromised natural resource conservation efforts and community interests. The challenges facing the Delta require a coordinated approach to planning and management of the resources in the Delta. Only land use planning can provide that opportunity, as sectoral planning tends to be single-resource focused.

Preparation of a Land Use Plan for Tana River Delta to guide policy formulation and decision-making on future development of the Delta started in September 2011 through the Ministry of Lands and with involvement of other agencies. It is part of a programme to coordinate the sustainable management of Deltas in Kenya, initiated in July 2011 by the Office of the Prime Minister with an Inter-Ministerial Technical Committee composed of 18 ministries. This SEA was conducted concurrently with the Tana River Delta land use planning process. The SEA in particular seeks to strengthen the integration of socio-economic and ecological aspects in the Tana Delta Land Use Plan. These include:

i. Describing the external and in-situ factors influencing land use in the Tana River Delta;
ii. Ensuring integration of stakeholders' socio-economic and environmental perspectives into the proposed LUP;
iii. Establishing the implications of the proposed LUP on Tana River Delta sustainable management and development;
iv. Identifying and mapping out specific habitats, natural resources or land use zones that should be preserved in perpetuity to ensure the survival of the Tana River Delta ecosystem;
v. Assessing alternative land use options that can inform the preferred strategy and plan.

In particular the analyses within this SEA were instrumental for the interrogation of development of land use options in the Tana Delta and the development of the preferred land use strategy that strikes the best balance between development and conservation.

The Tana River Delta SEA is based on the Organisation for Economic Cooperation and Development Assistance Committee (OECD-DAC) SEA framework on which Kenya's SEA Guidelines are largely based, and the World Bank approach to Institutional SEA in which attention is given to institutional strengths and weaknesses and the capacity of institutions to implement decisions.

ACKNOWLEDGEMENT

The Strategic Environmental Assessment (SEA) process for the Land Use Plan for Tana River Delta was carried out under the guidance of the Inter-ministerial Technical Committee (IMTC) on Deltas in Kenya. The technical production of the Tana Delta SEA was undertaken by the SEA Team, coordinated by Peter Odhengo initially from the Office of the Prime Minister and later from the National Treasury. The SEA team comprised representatives from various public and private organizations: Peter Odhengo (the National Treasury), Paul Matiku (Nature Kenya), John Nyangena (Kenya Institute for Public Policy Research and Analysis), Wahome King'uru (Ministry of Environment, Water and Natural Resources), Benard Opaa (National Environment Management Authority), Dickens Odeny (National Museums of Kenya), Serah Munguti (Nature Kenya), George Koyier (Ministry of Environment, Water and Natural Resources), Eugene Mmyamwezi (Ministry of Environment, Water and Natural Resources), and Paul Misati (Dynamo Consulting Ltd). The SEA team was responsible for compiling this report.

The Tana Planning Advisory Committee (TPAC), composed of representatives of key stakeholders at the local level, was instrumental in providing information for this report as well as in creating awareness among the communities by organizing and participating in village consultations. Helen Byron of Royal Society for Protection of Birds (RSPB) in United Kingdom provided technical support while Peter Nelson of Planning Green futures (PGF) provided consultancy services throughout the process. The Netherlands Commission for Environmental Assessment reviewed initial reports and ensured compliance to international standards. To all these we would like to express our deep appreciation.

We are highly indebted and also grateful to Nature Kenya for mobilizing funding from DFID, the Royal Society for the Protection of Birds, US Fish and Wildlife Service, Ecosystem Alliance (IUCN Netherlands, Wetlands International and Both ENDS) and the World Bank to support this activity, providing logistical support, and availing personnel at the local level during community consultations.

Sincere thanks go to the Governments of the Tana River and Lamu Counties, the Government of Kenya through Ministries, agencies and non government institutions which provided technical staff to the IMTC: Ministry of Environment, Water and Natural Resources; Ministry of Agriculture, Livestock and Fisheries; Ministry of Information, Communication and Technology; Ministry of Planning and Devolution; Ministry of Land, Housing and Urban Development; The National Treasury; The Ministry of Interior and Coordination of National Government, Government Agencies: Kenya Wildlife Service, Kenya Forest Service, National Environment Management Authority, Kenya Institute for Public Policy Research and Analysis; National Museums of Kenya, Tana and Athi Rivers Development Authority, Imarisha Naivasha Board, and Civil Society: Nature Kenya - The East Africa Natural History Society; the Royal Society for the Protection of Birds and the World Wide Fund for Nature.

Peter O. Odhengo
Deltas Secretariat Team Leader
The National Treasury

PREFACE

A Strategic Environmental Assessment (SEA) comprises an analytical toolkit for strategic decision-making that aims to integrate environmental considerations into policies, plans and programmes. This SEA was conducted to inform the process of formulating the Tana Delta Land Use Plan. It outlines the main measures that must be taken towards achievement of sustainable development of the delta: describing the factors influencing land use; ensuring integration of stakeholders' socio-economic and environmental perspectives into the Land Use Plan; assessing the implications of the plan on the Delta's sustainable management; and, assessing alternative land use options for the Land Use Plan. Without consideration of such measures, the future of the Tana Delta will continue to be threatened by multiple factors, some of which are external to the Delta.

Tana River Delta is an important area for biodiversity and environmental services. It contains a very wide variety of habitats, including riverine forest, grassland, woodland, bushland, lakes, mangroves, dunes, beaches, estuaries and coastal waters. Some of the globally threatened bird species found in the area are Malindi Pipit, Basra Reed Warbler and Tana River Cisticola. Other important biodiversity resources found in the Delta include hippos, crocodiles, wetlands, mangrove forests, fisheries and fisheries spawning grounds.

The Tana Delta is under pressure from declining water in River Tana, rising human population, intensive economic activities, and land use changes. Thus, there is urgent need to regulate the way in which land is currently allocated to various users and interest groups. A Land Use Plan spearheaded by the County Governments of Tana River and Lamu provides a framework for decision-making at both national and county level. This Strategic Environmental Assessment was conducted to inform and guide the Tana Delta Land Use Plan.

This SEA provides, perhaps for the first time, a detailed assessment of key issues that drive change in the Tana Delta and offers options for integration in the Land Use Plan. The SEA report is the product of a wide consultation ranging from local communities at the villages, government and civil society personnel at county and national level, as well as technical input from international SEA experts.

The SEA has demonstrated conclusively that, contrary to the established view that flood events originating in the Upper and Middle River Tana catchment have little or no effect on the delta, the lower River Tana responds in the same way to rainfall events in the highlands as the upper river. It is also affected by flash flooding from major seasonal streams, which bring very large but unquantifiable volumes of flood water into the delta.

Political and social conditions in the Tana Delta have been volatile for some decades, reflecting the very different lifestyles, culture and livelihood requirements of the two main groups of inhabitants which are based on sedentary farming and livestock rearing. Evidence from the SEA suggests that competition for scarce natural resources is certain to increase in the short term, and only the introduction of agreed standards for land use planning can help to minimise disputes. Rising human population has reduced the width of migratory corridors, as witnessed in some areas where individual homesteads have been built within the corridors. The Delta also faces real threats from the impacts of proposed developments in the larger coastal region such as the Lamu Port South Sudan Ethiopia Transport corridor, Tana Delta Irrigation Project and the High Grand Falls Dam. Based on this background, the SEA concludes that any future development of the Delta should be based on a combination of self-sufficiency, community-led enterprise and public/private partnership.

This Land Use Plan calls for bold action to ensure a good mix of development activities and conservation of natural resources through creating job opportunities and sustainable economic activities.

Economic activities should include improved management of livestock within the Delta and surrounding areas and the promotion of community based farming enterprises, supported by private partners. Development of freshwater fisheries will also be continued and extended since it can provide significant income as well as an important source of food and protein. A core area of habitats including riverine forest, forests fragments, mangrove forests, and wet grassland in the floodplain will continue to service a wide range of functions, including materials for house building, food, medicinal plants, honey and livestock grazing. Establishment of nature conservancies to support tourism and strengthen communities will become important income-generating sources of new employment.

The SEA recommends that a hierarchy of settlements is approved under the Land Use Plan where priority will be given to provision of public services. Main urban settlements that form the first tier include Garsen, Witu, Tarasaa and Kipini. A secondary tier of settlements should be identified based on detailed surveys undertaken in the next 2-3 years.

For future irrigation schemes to succeed, the first requirement will be for these to be owned and developed by the communities themselves in partnership, where appropriate, with relevant business and technical experts. A key issue for all irrigation schemes is to determine a reliable source of water. Attempts to divert the Tana River and provide weirs and sluices have often failed because the river has subsequently adopted a new meander pattern after flooding.

Solutions to provide employment opportunities must lie in adding value to local produce through processing, manufacturing and trading and effort should be focused on creating marketing cooperatives for packaging and transporting foodstuffs to major national markets. Vegetable production could be a major economic activity in the Tana Delta, providing that the necessary transportation and marketing facilities are developed in tandem with food production. The range of crops that can be grown in the Delta is very wide and this, combined with opportunities for growing three crops a year, provides major opportunities. Some enterprising farmers from both the Pokomo and Orma communities are already growing tomatoes and other vegetables on a commercial scale in the lower delta.

The SEA puts strong emphasis on developing both subsistence and commercial agriculture and manufacturing and industry. In consequence there will be pressures on natural resources in the Delta, particularly in terms of conversion of wet grassland to farming areas. These pressures will need to be managed carefully by introducing local settlement development action plans, and an overall management plan for the core area of the Ramsar site in order to prevent random growth and development which could fragment the ecosystem and cause disproportionate damage to precious habitats.

The Land Use Strategies that are explored in Scenario C will require increased cooperation between pastoral communities in managing livestock and similar demands for cooperation between farming communities in the development of joint enterprises between groups of farmers and business partners. Reducing current tensions in the Tana Delta over land and water resources will not be achieved overnight. Instead it will need to follow a series of steps. The first of which is to introduce the concepts of sharing resources which underpins all of the analysis set out in this SEA.

OUTLINE

Chapter 1 Context and Role of SEA
This chapter outlines the LUP/SEA processes, described in the SEA Scoping Report. It sets the context for readers who have no prior knowledge of the process or purpose of the Tana Delta SEA.

Chapter 2 Situation Analysis
A summary of the key issues and information provided in the SEA Baseline Report.

Chapter 3 National and Regional Development Scenarios
This chapter deals with 'macro-level' issues affecting the entire Tana River Basin and North East Kenya. National Scenario 1 paints a picture of what the growth and development forecasts for the Tana River Basin (and other regional geographic and administrative areas) are likely to mean for the lower Tana River and the Tana Delta in 2030. National Scenario 2 considers possible changes between 2030 and 2050.
The key components that are assessed are:

1. Population
2. Livelihoods
3. Social Welfare
4. Economic Activity
5. Water (demand, supply and balance)
6. Biodiversity

Chapters 4-8 The Existing Situation and Scenarios for the Tana Delta

Chapter 4	Assessment of the Existing Situation
Chapter 5	Assessment of Scenario A
Chapter 6	Assessment of Scenario B
Chapter 7	Assessment of Scenario C
Chapter 8	Summary of findings on the existing situation and three scenarios

Chapter 9 Conclusions and Recommendations
This chapter sets out guidelines and recommendations to assist decision-makers in constructing, adopting and implementing the final Land Use Plan (LUP).

Annexes The report contains a number of technical annexes

PART ONE

THE BASELINE

CHAPTER 1 Context and Role of SEA

1.1 Background

The Tana River Delta lies at the end of Kenya's longest and largest river and covers an area of over 100,000 hectares (or 225,000 ha, including the adjacent terraces). It is one of the most distinctive parts of Kenya. The Tana Delta lies on Kenya's North coast and has, for more than a century, been isolated from the rest of the country by poor roads and its own forests, swamps and marshes. During the rainy seasons the core areas of the delta are largely impenetrable, except by boat and canoe, when flooding turns most of the delta into a vast lake and wetland. These physical characteristics create an area of international importance for plants, birds, and other wildlife.

At the same time the area supports a number of ethnic communities whose way of life is completely adapted to this special environment with alternating floods and droughts. One group, the Pokomo, are farmers who have cultivated the banks of the River Tana for over a century. Another group, the Orma, and Wardei, are pastoralists who used to migrate with their herds of cattle, sheep, goats and camels but have adopted permanent settlements in the Tana Delta over the last sixty years. A third group, the Luo and Luhya, were attracted to the Delta in order to continue their traditional way of life based on freshwater fishing. The Mijikenda/Giriama and other tribes are more recent migrants, who have travelled from other parts of Kenya in search of vacant land on which to farm and rear livestock.

Since the colonial era the Delta has been considered, erroneously, as a largely undeveloped area suitable for agricultural development using water from the River Tana. However, all of the historic schemes for large scale irrigation have been costly failures, because they were designed without proper understanding of the hydrology and with little or no regard for the needs of existing communities. Poor management has also contributed to the collapse of most of these projects. Within the last decade a new threat to the Delta has emerged through widespread international interest in exploiting the area's resources for biofuels and food export schemes.

Rising population within the delta and increasing competition for its limited resources of water and land have all led to increased tensions between different groups, which have historically spilled over into violence, often coinciding with periods of political activism associated with national elections. The most recent clashes in 2012 -2013 resulted in the massacre of more than 180 men, women and children.

It is against this background that the Government of Kenya in conjunction with Nature Kenya, Africa's oldest conservation society, decided to adopt a new approach to planning and resource management by preparing a Land Use Plan (LUP) guided by Strategic Environmental Assessment (SEA).

1.2 Conduct of the LUP and SEA

Since November 2011, the Government, through the Ministry of Lands, has been formulating the Land Use Plan (LUP) for Tana River Delta to guide the decision making process on the future development of the Delta. Following devolution of many planning functions to the new County governments in March 2013, this responsibility has been shared with the Tana River and Lamu County Governments.

The LUP will significantly influence the way land is allocated to various users and interest groups by providing a framework for decision-making at both national level and in the devolved county government. Given the implications of the LUP on the sustainable development of the Delta, it was considered important to subject it to a Strategic Environment Assessment (SEA) process.

1.3 Role of the SEA

The SEA seeks to strengthen the integration of socio-economic and ecological aspects in the LUP by:

- Describing the external and in-situ factors influencing land use in the Tana River Delta;
- Ensuring integration of stakeholders' socio-economic and environmental perspectives into the proposed LUP;
- Establishing the implications of the proposed LUP on Tana River Delta sustainable management and development;
- Identifying and mapping out specific habitats, natural resources or land use zones that should be preserved in perpetuity to ensure the survival of the Tana River Delta ecosystem;
- Assessing alternative land use options that can inform the preferred strategy and plan.

The process has adopted a consultative approach with all stakeholders interested in the Delta. It is based on the Organisation for Economic Cooperation and Development Assistance Committee (OECD-DAC) SEA framework on which Kenya's SEA Guidelines are largely based, and the World Bank approach to Institutional SEA in which attention is given to institutional strengths and weaknesses and the capacity of institutions to implement decisions.

1.4 Policy Context

Concern for environmental planning in Kenya started back in 1974 with the adoption of a National Development Plan. In this plan, competition and conflicts between land use interests were observed to be growing, hence a need for greater co-ordination between various agencies of the government (Government of Kenya, 1974). The subsequent development plan (1979-83) stressed the needs for environmental inputs in the national planning process pointing out that environmental considerations must permeate development decisions at every level. The urgency of this concern was reflected in the 1994-96 development plan which called for a Sessional paper on sustainable development to set comprehensive guidelines and strategies for government action. This Sessional paper was however not produced. A National Environment Action Plan was produced in 1994.

Nonetheless the principles of sustainable development are enshrined in the Constitution of Kenya, 2010. Chapter five Part 1 Section 60(1) of the Constitution states that land in Kenya shall be held, used and managed in a manner that is equitable, efficient, productive and sustainable, and in accordance with the principles of land policy with equitable access to land, security of land rights, sustainable and productive management of land resources, transparent and cost effective administration of land, sound conservation and protection of ecologically sensitive areas, elimination of gender discrimination in law, customs and practices related to land and property in land and encouragement of communities to settle land disputes through recognised local community initiatives consistent with the Constitution.

Section 60(2) recognizes the national land policy developed by the national government to guide the implementation of the land holding policies. Section 61(1) of the Constitution vests all land in Kenya to the people of Kenya collectively as a nation, as communities and as individuals and section 61(2) classifies land as public, community or private. Section 61(1g) recognizes government forests and section 63 (3) says that any unregistered community land shall be held in trust by county governments on behalf of the communities for which it is held. Section 65(4) empowers the Parliament to enact relevant legislation to further guide land ownership and use in Kenya. The National Land Commission is to manage public land on behalf of the national and county governments and recommend national land policy to the national government.

Environment and Natural Resources are provided for in Section 69(1) and the state is expected to:

- ensure sustainable exploitation, utilisation, management and conservation of the environment and natural resources, and ensure the equitable sharing of the accruing benefits;
- work to achieve and maintain a tree cover of at least ten per cent of the land area of Kenya;
- protect and enhance intellectual property in, and indigenous knowledge of, biodiversity and the genetic resources of the communities; encourage public participation in the management, protection and conservation of the environment;
- protect genetic resources and biological diversity;
- establish systems of environmental impact assessment, environmental audit and monitoring of the environment;
- eliminate processes and activities that are likely to endanger the environment; and
- utilise the environment and natural resources for the benefit of the people of Kenya.

1.5 SEA Preparation Process

In its first meeting on 19thJuly 2011, using its convening power the Office of the Prime Minister (OPM) formed an Inter-Ministerial Technical Committee (IMTC) made up of twenty two relevant government ministries and agencies . This was followed by the formation of a core team comprising of 11 members from OPM, NEMA, Kenya Wildlife Service (KWS), Kenya Forest Service (KFS), Ministry State for Planning, National Development and Vision 2030 (MPND & V2030), Ministry of Lands (MOL), Ministry of Agriculture (MOA), Ministry of Water and Irrigation (MOW&I), Nature Kenya (NK) and IMARISHA Naivasha Board.

From24th–26th July 2011, the core team of the IMTC developed a strategic framework to oversee planning for deltas in Kenya starting with the Tana River Delta. The overall purpose of the strategy is to provide a roadmap and governance structures that would guide the Kenyan Deltas initiative to undertake General Management Planning that use participatory approaches to identify actions, define strategies, timelines and milestones to achieve sustainable development framework for Kenya's deltas .

1.5.1 Launch of the Tana Delta Planning Process

In September 2011, the IMTC convened a high level meeting in Malindi to inform local stakeholders and discuss the need for a strategic plan for the Tana River Delta. Sixty five (65) participants took part in the meeting. The meeting was hosted by OPM, while NEMA and Nature Kenya provided joint Secretariat.

Representatives from key Kenyan government ministries and agencies attended together with local community representatives, NGOs, media and international experts in the fields of land use and delta planning and SEA. The meeting included a workshop and a field visit into the Tana River Delta to provide an opportunity to interact and consult with the local people to understand the issues first hand.

The meeting concluded by adopting a Communiqué which confirmed the launch of the Tana Delta planning initiative . This noted that the aim of the initiative is to produce a long-term strategic land use plan representing a 'truly sustainable' future to the delta, informed by Strategic Environmental Assessment and that the process would take place over the next 18 months, with the support of Department for International Development - United Kingdom Aid (DFID-UKAid).

In a follow up meeting on 27th September 2011 the IMTC agreed that Ministries of Lands, Planning, Environment and OPM should second officers to the secretariat in order to support an international consultant in developing the SEA and LUP process for the Tana Delta. An officer from the Ministry of Lands would lead a Land use planning (LUP) team, while one from MPND & V2030 would lead the SEA team. The two teams would comprise technical officers working on the Tana Delta LUP and SEA, and be advised by an international consultant and the Netherlands Commission for Environmental Assessment

OPM provided office space and furniture for the secretariat, while Nature Kenya equipped the office with computers, a printer and other basic office equipment. The international expert provided technical advice to the Secretariat. A manual on Tana LUP and SEA was developed and the terms of reference for the secretariat agreed upon.

During the IMTC site visit in September 2011, the Tana Delta site based Planning Advisory Committee (TPAC) was constituted. The TPAC was made up of 21 members of which 19 represent local community interests including pastoralists, fisher folk, farmers, women groups, development oriented CBOs, conservation groups, marine fishermen, people with disabilities, among others. Four key government agencies made up the other 4 PAC members and included the District Development Officer, District Livestock Officer, District Agriculture Officer and District Commissioner. The March 2013 general elections ushered in a new devolved governance system centered on counties. Consequently the TPAC became greatly expanded (to a membership of 67) to accommodate county government interests. The PAC is convened under the authority of a chair appointed by the County Governments and each meeting is chaired by a TPAC member selected on rotation. The role of the committee is to provide advice and feedback on the content of the LUP and SEA based on papers to be presented to it. In this respect, the TPAC mirrors the work of the IMTC at national level within the Delta.

1.5.2 Stakeholder consultations

At the launch of the Tana Delta planning process in September 2011, the IMTC held launch event meetings at District level (Gamba Guest House) and local launch events at Moa, Dide Waride and Tarasaa.
From 1st-3rdFebruary 2012, the IMTC launched the LUP for Tana Delta at divisional level (Kipini, Garsen and Tarasaa) followed by village level meetings at Gatundu, Moa and Ozi. In March – June 2012 Nature Kenya staff in Tana Delta and District Livestock Production Officer, District Agricultural Officer and District Development Officer conducted meetings in all the 106 villages in the Delta to facilitate community members to provide input via a questionnaire that was developed and reviewed by the LUP and SEA teams. The outcomes of village land use planning meetings included development of initial Village LUP maps, which fed into the LUP process and will further inform its implementation.

In March 2012, the SEA working group held meetings in Kipini, Danisa, Kibusu, Moa, Dide Waride to collect data on issues affecting the communities in Tana Delta for planning purposes. The SEA secretariat held discussions with the county councils of Tana River and Lamu, both recognized as important players in the Tana Delta. This helped clarify the purpose of the entire process and defuse any suspicion. The Water Resources Management Authority, Tana catchment Regional Office, was also visited and important information obtained that informed the SEA. It however emerged that the Water Resource Users Associations (WRUAs) were yet to be established in the lower delta.

1.5.3 Independent Review

In November 2011, NEMA requested the Netherlands Commission for Environmental Assessment to advise on the Strategic Environmental Assessment of the Land Use Plan, for the Tana Delta in Kenya. The Commission and NEMA agreed to apply a two-step approach: firstly the Commission would advise before the start of the LUP/SEA on the overall process and approach of the LUP/SEA. Secondly, the Commission would provide advice on (i) the process, more detailed based upon field observations and discussions with members of the LUP and SEA team and (ii) on the contents of the SEA and the Land use plan. Copies of the Commission's comments were made available through the Deltas Secretariat and published on the Commission's website. On both occasions advice received guided the focus and SEA/ LUP process on methodology and on the need to centre the LUP on water availability in the catchment. Nature Kenya, the international consultant and the Deltas Secretariat responded to the Commission's advice. The Commission has also agreed to review the draft final LUP and SEA on completion of these two documents.

CHAPTER 2 Situation Analysis

Introduction

As a precursor to the drafting of the Tana River Delta SEA, a SEA baseline report was drafted analysing conditions in the river's catchment in the base year, taken to be 2010. Similarly a LUP baseline report was drafted analysing conditions within the Tana Delta in the base year. This chapter describes baseline conditions and provides a summary of salient facts drawn from the SEA and LUP Baseline reports. It also draws on information collected for the development of scenarios and the accompanying analysis, which is published in the Tana Delta Land Use Plan. The full baseline reports should be consulted for a detailed account of existing conditions in the River Tana Catchment and the Plan Area (the latter comprising the Tana River Delta and the buffer zone).

This Chapter is in five parts. The first (this section) introduces the River Tana Basin Catchment and Tana River Delta. The second and third introduce the key socio-economic and environmental concerns respectively. Part four covers issues relating to biodiversity and the final section summarises the key current issues for the basin and delta, which will be considered further in this SEA.

PART ONE: DESCRIPTION OF THE TANA RIVER BASIN

2.1 Geography of the Tana River Basin

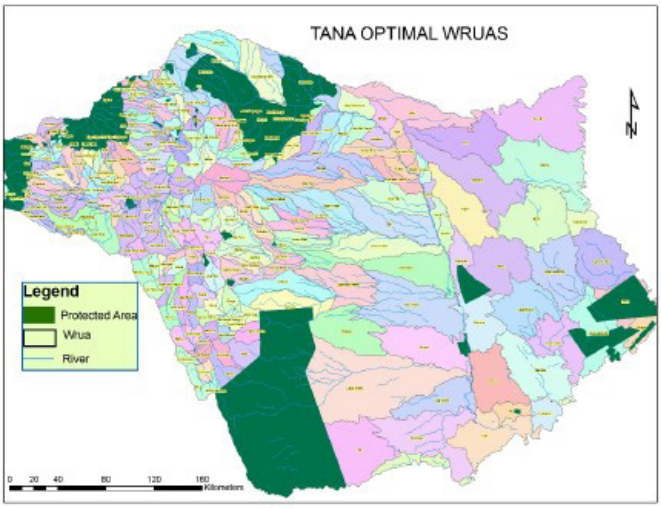
The River Tana catchment falls within latitudes 0° 30' North and 2° 30' South and longitudes 37° 00' East and 41° 00' East. It has an area of 126,000 km^2 (equivalent to 21.7% of the land area in Kenya) and a population of over 7 million people (Water Resources Management Authority, 2009).

River Tana provides the main drainage system in the catchment. The mean annual discharge of River Tana is 4,000 million m^3. The sources of River Tana are in the highlands of the Aberdares and Mount Kenya (3000 m above sea level), and the river flows for about 1000 kilometers to its mouth at Kipini into the Indian Ocean.

The catchment comprises of the upper, middle and lower catchment areas. The upper catchment covers an area of 15,000 km^2 and extends to Kamburu dam, which stands at around 1,000 m asl. About 70% of Kenya's hydropower is produced in the upper catchment. The middle catchment covers an area of 15,700 km^2 lying within altitudes of 1,000 and 200 m asl, while the area below 200 m asl covering an area of 95,300 km^2 makes up the lower catchment (Water Resources Management Authority, 2009).

Once the river descends below 200 m asl, it meanders through a floodplain about 5 km in width and 300 km in length before entering the Tana River Delta at Garsen (Hamerlynck *et al*, 2010) and ultimately discharging its silt-rich, muddy waters into the Indian Ocean at Ungwana (formerly Formosa) Bay. The Tana River Delta is located in both Tana River and Lamu Counties and its floodplain covers an area of over 100km^2 (Water Resources Management Authority, 2009). It is situated about 250 km northeast of Mombasa and about 600km southeast of Nairobi. For planning purposes, the core area of the Delta is extended to include the raised terraces on the Delta's eastern and western flanks and extends to 2,250km^2 in total. In addition, for planning purposes a buffer zone 20 km wide has been defined around the delta and this adds a further 4,000 km^2 to the area covered by the Tana Delta Land Use Plan (LUP).

Figure 2.1 River Tana Catchment



Source: Water Resources Management Authority, 2008

2.2.1 Climate

The climate of the Tana River Basin is governed by seasonal movements of the inter-tropical convergence zone (ITCZ) creating the Southeast and Northeast monsoon winds, which are responsible for the seasonal distribution of rainfall. Climatic conditions for the catchment range from humid in the highlands to very

arid in the lowlands. Similarly, temperatures vary from 10^0C to 30^0C. Mean annual rainfall ranges from 2,400 mm – 200 mm. Rainfall is bimodal. More rain falls during the long rains season of March – May, and lesser amounts in the short rains season of October-December (Government of Kenya, 2008).

The Tana Delta is characterized by low and unreliable rainfall. It receives low and erratic bimodal rainfall that is highly variable in both space and time. In most cases, rain falls as short high intensity storms that produce considerable runoff and soil erosion. Average rainfall figures are deceptive in these circumstances because there tends to be a few years of rainfall well above average whilst the probability of occurrence is low. Mean annual rainfall ranges between 300 – 900 mm per annum. The average temperature is 300C and average humidity is 85%. The slightly higher levels of rainfall along the coast support crop production and mangrove forest. However due to its low altitude, the south-eastern part of the delta is susceptible to salty sea water intrusion, which affects agricultural activities (Government of Kenya, 2008).

2.2.2 Land Cover

Land cover in the Tana catchment reflects the climatic range and varies from alpine type at the top of Mt. Kenya through moorlands, tropical forests, savannah grassland in the middle region to semi-arid lands and coastal mangrove forest. The basin has over 80% of its land under Arid and Semi-Arid Land conditions.

Agricultural production in the basin is varied, according to the agricultural potential. In the high potential areas, coffee, tea, pyrethrum, wheat and barley; dairy, sheep and poultry are the main activities (Jaetzold and Schimidt, 1983). The medium potential areas support maize, sunflower and beans as the major crops with some poultry, sheep and dairy; while in the low potential zones, millet, cotton, tobacco and sorghum are the main crops, together with cattle, goats and sheep.

The irrigation potential in the catchment is estimated at 132,000 hectares (1320 km2) with the present developed and planned irrigation schemes covering an area of 54,676 hectares comprising 30,148 hectares under private schemes and 24,528 hectares managed by various government organizations (Government of Kenya, 2008). Different types of irrigation schemes are found within the catchment namely: small-scale group based schemes (involving horticulture, floriculture and subsistence crops), individual holder schemes (for nurseries of high cost crops such as macadamia and ornamental crops) and public irrigation schemes (managed by government agencies). (Government of Kenya, 2008).

The catchment plays an important role in the national economy through provision of electricity. There are many hydro-generation plants constructed on River Tana, with the main power plants located in the Seven Forks within the middle catchment. These account for nearly 70% of electricity in the national grid. There are plans to construct another 5 billion cubic metre multipurpose dam at High Grand Falls to increase hydropower capacity, provide water for irrigation, domestic use and supply the upcoming Lamu Port.

PART TWO: SOCIO-ECONOMIC CONDITIONS AND LAND USE

2.2 Socio-economic Conditions

2.2.1 Population and Communities

River Tana catchment has a population of over 7 million people (Water Resources Management Authority, 2009). The population of the Delta is estimated to be 102,000 (Odhengo et al, 2014b). According to the 2009 national census the Tana Delta population is distributed across 12,457 households giving an average household size of about 8 persons, with 65,000 people living on the drier terrace areas, 35,000 people living in the floodplain and fewer than 2000 people living on the coast (Government of Kenya, 2010).

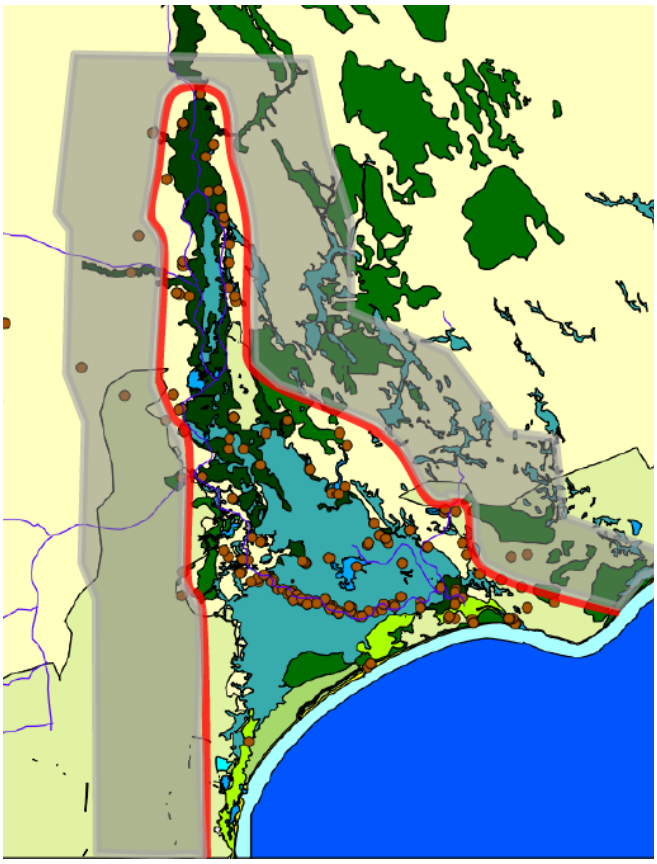
Although the SEA concentrates its attention on conditions in the Delta, it is important to note that there are more people living in the section of the narrow flood plain of the Tana River lying between the High Grand Falls Dam and the Tana River Primate National Reserve. Much of this land is very fertile and reference to Google Earth mapping shows that there are numerous villages with fruit orchards and areas of cultivation which have received very little attention in any socio-economic and analysis of the Tana River Basin.

The Tana River Delta is inhabited by three major communities – Pokomo (44%), Orma (44%) and Wardei (8%). Other ethnic groups (including Bajuni, Luo, Luhya, Wataa/Sanye, Boni, Malakote and Munyoyaya and more recently Giriama and Somali) account for the remaining 4%. The Pokomo people are subsistence farmers while the Orma and Wardei people are pastoralists who have used the Delta for centuries (Government of Kenya, 2010).

2.2.2 Settlements

The main urban areas in the Plan Area are Garsen, Tarasaa, Witu and Kipini. Nearly 93 % of the people live in rural areas in more than 100 villages and practice crop farming, livestock keeping and fishing – see Figure 2.2. The settlement patterns have largely been influenced

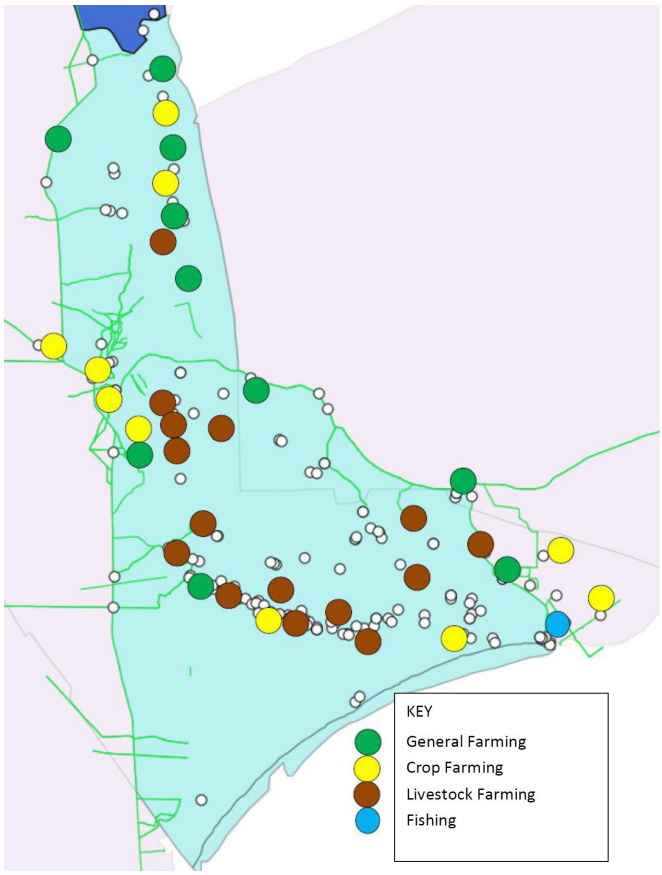
Figure 2.2 Settlement Patterns in the Tana River Delta showing location of villages



Villages are mostly located along the main river channel

Source: Tana Delta Land Use Plan, 2014

Figure 2.3 Settlement patterns in the Tana River Delta by livelihood source



Source: Tana Delta Land Use Plan, 2014

by River Tana and the socio-cultural practices of the communities. Most farming and fishing communities reside along River Tana and the wetlands. Pastoralists are mainly found in the hinterland in areas with watering points and pasture. In addition, pastoralists migrate from the Garissa and other northern counties to the Tana River Delta during the dry season and return during the rainy season.

The majority of houses in the planning area are temporary structures and less than 1% of the residential houses are semi-permanent or permanent (Government of Kenya, 2010). Pastoralist communities tend to live in temporary houses, agriculturalists in semi-permanent or permanent houses. The rapid growth in population and tendency for pastoralists to give up their migratory way of life in the face of increasing competition for grazing have contributed to the formation of more permanent and dense settlements. There is encroachment and degradation of wetlands and other protected areas. There is a real and potential threat to biodiversity and also widespread charcoal burning for domestic use and income.

The nature of settlements in the Delta has also been a hindrance to the provision of infrastructure - see Figures 2.2 and 2.3. Though clustered, the settlements are located in remote areas and are only concentrated along the river and urban centres. At the same time, pastoralist communities usually move with their livestock in search of pasture and water. It has therefore not been feasible to roll out infrastructure as it will not be fully utilized.

2.2.3 Land Tenure

There are three categories of land ownership in the Delta: private, communal and public. Privately held land includes the six community ranches (which in practice have squatters living on them in some areas). In recent years, there have been proposals for large scale private land allocation in the heart of Tana Delta involving six major investors (Nunow, 2011). The public land in the Delta includes Gazetted forests, the beach front and marine waters. The rest of the land is held under communal ownership with recognition of individual title to cultivated land. The communal ownership system does not encourage local and external investment. But it protects traditional ownership, maintains community

cohesion, allows space for the natural environment and should be respected.

The land question in the Delta remains a challenge. The majority of local communities have no land ownership documents. Large tracts of land are owned by relatively few individuals while the majority occupy land which they claim is ancestral although it remains un-adjudicated. Due to the tenure insecurity, squatters rarely practice farming and have resorted to charcoal burning as a means of earning their livelihood. This has resulted in a massive reduction in vegetative cover due to felling of trees. There is also a need to review land leases granted to large investors, including foreign companies, in order to secure tenure for the local communities and resettlement of the squatters.

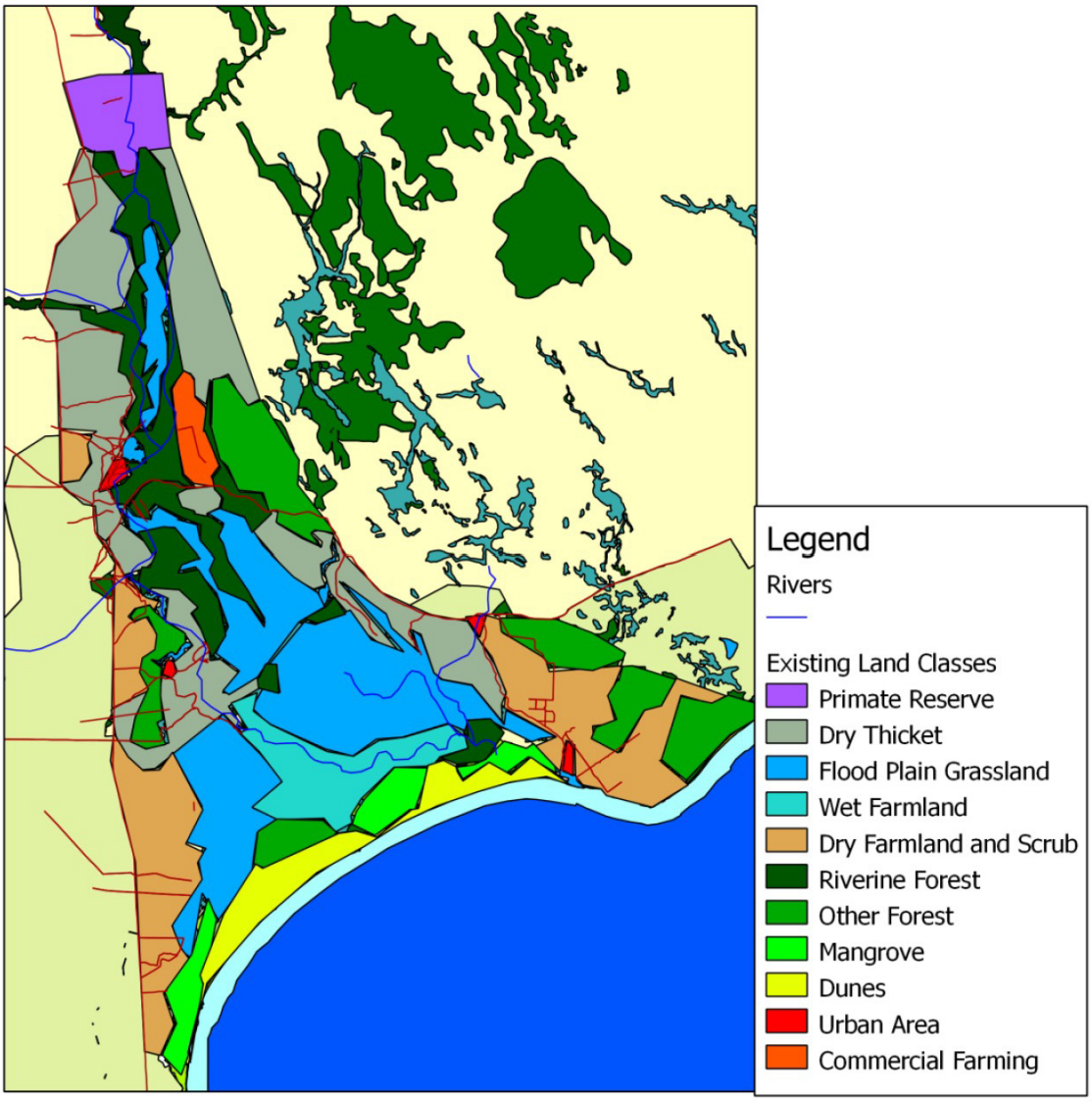
The community survey carried out as part of the LUP/SEA process revealed that the following are seen as major concerns raised by over half the villages:

- Lack of title deeds and confusion over ownership and rights to the use of land and water (raised by over half of villages)
- Land-grabbing by both private developers and the public sector and the tendency for major development to occur without adequate consultation and with disregard for the ownership and access rights of the communities.

2.3 Land Use in the Tana Delta

Figure 4 prepared as part of the LUP/SEA process shows "land use classes".

Figure 2.4 Land Use Classes in the Tana Delta Planning Area



Source: Tana Delta Land Use Plan, 2014

Table 2.1 Areas Occupied by Various Land Use Classes in the Tana Delta Planning Area

Land Use Classes	Area Km^2	Percentage
Forest	271	12.0
Riverine Forest	323	14.4
Thicket and scrub	400	17.8
Mangrove	84	3.7
Water Areas	18	0.8
Salt ponds	5	0.2
Dunes	103	4.6
Dryland farming	370	16.4
Commercial farming	31	1.4
Urban Areas	14	0.6
Floodplain grassland	508	22.6
Wetland farming	123	5.5
Total	2,250	100

Source: Tana Delta Land Use Plan, 2014

2.3.1 Livestock

Livestock rearing and management occurs throughout the Plan area with cattle, goats, sheep and a small number of camels being grazed in open grassland, scrub, thicket and forest margins and on agricultural land after crops have been harvested. There are no accurate statistics for the numbers of animals kept by each household - estimates are shown in Table 2.2.

Table 2.2 Number of Animals per Household (2010)

Animal	No. Recorded	Animal/Household
Cattle	211,858	21.3
Sheep	131,154	13.2
Goats	118,676	11.9
Camels	360	0.036

Source: Tana Delta Land Use Plan, 2014

It is not possible to determine the absolute number of cattle in the Delta, as this varies seasonally and with the inward and outward migration of herds, but analysis for the LUP/SEA indicates that in the wet season there are around 220,000 head rising to around 735,000 in the dry season.

Cattle, other livestock and wild herbivores graze all accessible areas of the Delta and the buffer zone. The only areas that receive little or no grazing include dense forest, permanently flooded swamps, mangrove forests and other impenetrable habitat, amounting to between 5-10% of the Delta. Farming areas receive very low levels of grazing unless crops are invaded during droughts or farmers allow grazing to introduce manure to fallow areas. Thicket and scrub are invariably heavily grazed, especially in the dry season but the slow growth rates of shrubs and grasses, due to dry and infertile soils means that the nutrition rates are low.

The principal grazing areas are found on the wet grassland within the flood plains, amounting to between 70,000 and 100,000 hectares (depending on rainfall variation and the extent of flooding from year to year).

In the dry season the level of cattle grazing in the Delta is exceeding the carrying capacity of the environment leading to both environmental damage and conflicts. The Plan will need to propose strategies for achieving sustainable levels of grazing.

2.3.2 Farming

Farming practice includes permanent cultivated and fruit growing areas around settlements, small irrigated areas, temporary slash and burn for rain-fed cultivation, and areas of flood recession[4] farming where land is planted after the floodwaters have receded. The area currently farmed (wet and dry farming) or covered by thicket and scrub and equivalent to rangeland is estimated from mapping sources to be 89,300 hectares which represents 39.7% of the total. (In theory parts of the floodplain grassland could also be converted to temporary farmland, which would raise the percentage above 40%). Analysis for the LUP/SEA suggests that the average distribution per household of cultivated land is 0.6 hectares (1.5 acres).

The population in the Tana Delta is not self-sufficient in food. For much of the year, food relief is provided under the Government's Protracted Relief and Recovery Operations/Food for Assets programme, and especially during the drought spells it is a common phenomenon.

[4]Flood recession agriculture uses the residual moisture of seasonally flooded lands when the floods recede.

High poverty rates and climate change have been perceived as the underlying causes of food insecurity. The LUP will need to play a key role in ensuring food security by proposing strategies on sustainable agriculture and diversification of livelihoods.

Two irrigation schemes are operational within the delta, namely TARDA's integrated rice project (200 acres/81ha) and the Hewani and Wema settlement minor irrigation schemes (135 acres/55ha). The TARDA rice project has a chequered history and although production levels and yields have improved in recent years, the project has suffered in the past from repeated damage and erosion from flooding, poor management, inappropriate application of inputs and poorly maintained machinery.

A high level of agricultural expansion and intensification is proposed in the Delta with projects including the Mumias Sugar's Tana Integrated Sugar Project, Mat International's irrigation project and TARDA's ongoing revival of Tana Delta Irrigation Project (TDIP). This is likely to exert pressure on the land and resources in the Delta due to vegetation clearance, pollution and increase in water demand. The projects will also exert pressure on existing infrastructure. The pressures on the environment will ultimately lead to ecosystem disruptions and loss of biodiversity. In addition, the tapping of water from the river for irrigation will worsen the low water discharge from the river. A comprehensive strategy that rationalizes natural resources management should be put place in the implementation of the agricultural extension projects to avert the likely outcome of environmental degradation and biodiversity loss.

2.3.3 Fishing

Fishing is an important source of food and protein for many families in the Delta. Bajuni fishermen fish mainly in coastal waters, and the Luo community are the most active fisherfolk inside the Delta. The Pokomo also practice fishing in the inland waters of the delta but not as intensively as the Luo. Fishing takes place in the main river and subsidiary channels and open water bodies including ox-bow lakes (former river meanders cut off from the main channel). In addition, aquaculture is being introduced involving rearing of fish in both natural and artificially constructed ponds. In 2007 the total weight of fish caught was 613,003 kg (District Fisheries office, Tana Delta 2007).

Good quality water is essential to maintain healthy fish populations in the river channels and ox-box lakes within the Delta. Unfortunately, conditions have deteriorated over the last four decades with the building of dams in the upper catchment of River Tana. In particular, the reduction in seasonal flooding has severely affected fish breeding since fish spawn in shallow waters.

Marine fisheries are largely unaffected by inland river water quality although the decrease in silt and organic sediment load may have localised impacts. Changes to inshore hydrology may also affect marine species like shrimp which breed and feed in mangrove swamps in their juvenile stages.

2.3.4 Beekeeping

Much of the current beekeeping occurs around the riverine area where nectar is more abundant. The number of hives fluctuates from year to year. It is generally believed that the Delta has the potential to accommodate more hives as there is an abundance of suitable flowering species, ensuring continuity in floral resources for the bees throughout the year. Predation by honey badgers (ratels) is a constraint.

2.3.5 Natural Resources Production

The land use zones from which most raw materials are harvested are forests, riverine forests, floodplain grassland and mangroves (extending to 1186 km^2), although thicket and scrub also contributes significantly to charcoal and fuel wood production and this is already putting pressure on the environment.

2.3.6 Tourism

The Delta shelters a wide diversity of wildlife, from rare monkeys in the Tana River Primate National Reserve and vast flocks of waterbirds in the flooded grassland to the hundreds of hippos and crocodiles in the River Tana and a variety of savannah wildlife in ranches such as Nairobi Ranch (the privately-owned Kipini Conservancy). These could become major tourist attractions, as could the 76km of coastline – pristine white beaches. Tourism is underperforming (as at 2013-2014), despite its huge potential, largely because of recent conflict in the region. There are currently three established hotels and camps within the Tana Delta with a combined bed space of under 100, and a number of houses providing rooms for local travellers.

2.3.7 Industry and Mining

Industrial activities are minimal in the Delta at the present time. The main rice mill has recently been rehabilitated and is managed by TARDA but is only operating at about 30% its capacity due to low rice production. Factories to process mangoes into juice have been promised several times but never delivered. Mining activities are also very minimal. There is harvesting of sand and sea salt especially in the southern part of the Delta. There have been proposals for titanium prospecting in the Delta, and recently an oil company carried out a seismic survey for oil and gas.

2.4 Economic Base, Jobs, and Livelihoods in the Delta

The major economic activities in the Tana Delta are based on livestock keeping and farming, with livestock keeping contributing about 70% of the incomes of the households in the Delta. The workforce is 52,000. Estimates of the current number of jobs and value from the current livelihood activities produced for this LUP/SEA are summarised in Table 2.3.

According to a study conducted by Nature Kenya, potential income generating activities could be extended to include ecotourism, beekeeping, and tree planting. Household income could also be enhanced through value addition to the existing products of mangoes, rice, and fishing (Nature Kenya, 2012).

Table 2.2 Economic Activity in the Delta (2010)

Economic activity	No of jobs (FTE) or livelihoods	Value (annual income)
Livestock		
Open Grazing		5.73 billion Ksh (Ksh @ 12,000/head)
Ranches		5.7 million Ksh
Farming	12,409	62 million Ksh
Fishing	450-700	53.14 million Ksh
Beekeeping		29-29 million Ksh
Natural products	10,000-12,000	333-416 million Ksh
Harvested NTFP		80 million Ksh
Materials for construction and repair of houses		100 million Ksh
Charcoal and firewood		153-236 million Ksh
Trade commerce and financial services	3,488	74-114 million Ksh
Tourism		28,000 USD
Industry and mining	50	

Source: Tana Delta Land Use Plan, 2014

Poverty levels in the Delta are extremely high. About 95% of the population in the Delta depends on subsistence farming, livestock and use of natural resources for survival, which is putting pressure on the environment. For example, charcoal burning in forests and logging in the mangrove forests for hardwood has threatened to wipe out the indigenous forests and destroy habitats and biodiversity. The human activities in the wetlands have also threatened fragile ecosystems in the Delta. To counter the effects of poverty on the environment, the Tana Delta land use plan will propose strategies that will allow for diversification of livelihoods to avoid the dependence on rain fed agriculture and pastoralism as the only sources of livelihood for the communities in the Delta. More information about the economic value of different activities is given below.

2.4.1 Livestock

Cattle sales: depending on approaches used, estimates for trading output vary from Ksh 228 million to Ksh 1.26 billion. The larger figure may indicate internal trading within the Delta designed to increase the size of herds, and increase ownership even amongst the poorest households, while the lower represents the off-sales for exporting animals to outside markets.

Milk production: sales of milk from 9927 households amount to around 27,795 litres a day with a value of Ksh 834,000 at a farm gate price of 30Ksh per litre.

Sheep and goats: These animals play a vital role in food supply to households in the Delta and surrounding rangelands because they can tolerate drier conditions than cattle and survive on less productive vegetation. In 2006, a total of 4670 sheep and 5377 goats were sold from Garsen Division, representing a value of Ksh 20-30 million. This figure grossly undervalues the number of sheep and goats bartered within the communities on a day to day basis without involving traders and formal markets.

2.4.2 Farming

Subsistence farming is geared entirely towards providing food for the households involved, although small amounts of produce are traded or bartered for other provisions within each settlement. The Management Plan for Arabuko-Sokoke Forest in Kilifi County quoted farmers' earnings as KSh 10,007 per hectare for crop production in 2001. Taking the average of 1.5 acres per household for 9927 households (equalling 14,890 acres /6204 Ha) in the Tana Delta gives an a gross income, at 2001 prices, of KSh 62 million.

2.4.3 Fishing

Based on the annual catches in recent years it is estimated that between 250-500 individuals fish on inland waters and close to 200 fishers engage in sea fishing close to shore. The overall value of fish landed in 2007 was KSh 53.14 million.

2.4.4 Natural Resources Production

It is estimated that around 4,700-5,000 full time equivalent (FTE) jobs are created in harvesting edible products, craft materials and other natural resources. A further 540-725 full time jobs are created by house building and repair, together with 5,000 jobs in charcoal manufacture and fuel wood collection. The total number

of livelihoods supported by natural resources is therefore estimated to be in the region of 10,000-12,000.

2.4.5 Trade, Commerce and Financial Services

Trading activities in the Plan area are fairly low since access to credit is limited. The main commercial activities are concentrated in Garsen with lower order services in other centres such as Kipini, Ngao and Tarasaa. Formal commercial activities in the Plan area mainly consist of small scale wholesale and retail shops. These are mainly concentrated in Garsen town – the main urban centre. Information from the District Development Plan, 2008-2012, indicates that there were around 489 businesses in 2008. If it is assumed that each employed an average of three workers this would give around 1500 FTEs. However, trading is not restricted to formal businesses and bartering forms part of every household's economic activities. On the basis that trade represents one tenth of each household's income this equates to 1988 full time jobs within the plan area. The combined estimate for livelihoods based on Trade, Commerce and Financial services is therefore 3488 FTEs. The gross trading level for the Delta, based on 19,885 households, would be Ksh 74million – Ksh 114 million.

2.4.6 Industry and Mining

With the exception of salt processing, for which an estimated 50 FTEs are involved, the contribution of this sector to employment and incomes is minimal but has high potential. Exploration has recently commenced for oil and gas within the Lamu County section of the Tana Delta.

2.4.7 Infrastructure and Services

2.4.7.1 Transport and Communications

Infrastructure in the Tana Delta is poor. The only tarmac road that transects the area is the Malindi-Lamu Road. The access roads to the settlement areas are very poor having been destroyed by floods. The road from the main road to Ngao and Tarasaa is an all-weather road, as is the road from Witu to Kipini.. The former TARDA rice project area had access roads, which are totally broken down and in very poor condition. Access to most villages in the area is through paths and 98% of the community indicated that their villages are only accessible by foot throughout the year. The community survey showed that only 2.8% of households had electricity. Most households use firewood and charcoal for cooking and paraffin for lighting. Telecommunication is mainly through mobile telephones as 66% had mobile phones and 3.7% of the population has access to television (TV). Radio reach is relatively well developed with nearly half of the population (45.2%) owning a radio set.

2.4.7.2 Water, Sanitation and Waste

River Tana is the major source of water. A number of dams have been constructed by the National Water Corporation to provide water for the pastoralists, and two water supplies (in Garsen and Ngao) are managed by Coast Water Services Board. There are 95 shallow wells, 10 boreholes and ten water pans serving the communities that live away from the river (Tana Delta DDP, 2009). Due to its proximity to the Indian Ocean, ground water sources in most parts of the former Tana Delta District are saline. Due to flooding and poor sanitation the water quality is compromised. Over 90% of the population has no access to clean and drinkable water. Generally sanitation is poor with majority of the population having no access to basic sanitary facilities such as pit latrines. Even Garsen, the major town, has no sewerage system. Solid waste disposal facilities are poor or non-existent and as a result the majority of residents throw the rubbish outside.

2.4.7.3 Health

Generally health service provision is poor due to inadequate health facilities, the poor road network and a shortage of staff. The former Tana Delta District is served by one sub-district hospital at Ngao, two health centres and ten dispensaries. There are also eight private clinics scattered in the district. The doctor/patient ratio is 1:87,201 against the recommended World Health Organization (WHO) standard of 1:5000 while the nurses/patient ratio is 1:2,642 against the recommended WHO standard of 1:3-1:8. There is therefore need to deploy more medical staff in the area. Source: Tana Delta DDP, 2008-2012. Voluntary Counselling and Testing (VCT) and family planning services are also offered in the local hospitals and through various NGOs in the area.

2.4.7.4 Education Level

The education levels in the former Tana River District are very low. The District has one of the highest percentages of people who have never attended school in the entire country. A large percentage of the population in the former Tana River District (39.3%) has not attended school. The lack of education has negatively affected access to employment opportunities leading to general poverty in the area. The lack of access to educational opportunities has affected female members of the population more than males with 44.5% of females having never attended school compared to 34.1% of males (Government of Kenya, 2010).

Another study (Mumias Sugar and Tarda, 2007) showed that majority of those who have attended school have achieved only a primary level of education (39.4%) with those completing secondary and tertiary education being 14.4% and 4.4% respectively. This study also found that educational qualifications were widely varied

among the ethnic communities in the delta where 21% of the Pokomo, 38% of the Orma, and 85% of the Wardei had never attended school. It is estimated that only 33.7% of the district population is able to read and write (Government of Kenya, 2009).

2.4.7.5 Summary

Infrastructure is key in the development of any area. The planning area is under-developed in terms of infrastructure. The road network is poor affecting access to many areas in the Delta, especially during the rainy season. Lack of organized markets and market amenities have hindered trading, adversely affecting sectors such as agriculture. Basic services such as water and sewer reticulation are also lacking in the Delta. Provision of infrastructure and service in the delta is therefore a key element the LUP must address.

2.5 Development Trends

The main activities in the Delta are crop farming and animal keeping in the form of pastoralism. However pressure has been mounting on the land due to influx of investors in the area eyeing opportunities for commercial development of agriculture, mining and trade.

A number of Vision 2030 flagship projects will have great impact on River Tana and Tana Delta including the Lamu Port-South Sudan-Ethiopia Transport (LAPSSET) corridor, Tana Delta Irrigation Project (TDIP) and the High Grand Falls Dam. The LAPSSET project will draw water for domestic and industrial use from River Tana while the construction of the Lamu port will stimulate major economic development opportunities and result in a massive increase in population which will exert further pressure on the resources in the Delta. The construction of High Grand Falls Dam upstream for power generation, irrigation, water supply and flood control will also greatly impact on the Delta ecosystems and community livelihoods.

Despite the potentially huge impacts of these large projects on the Delta, it is hard to understand the details due to the lack of availability of information. It is understood that a SEA of the High Grand Falls Dam was to be carried out, but the status of this process (which should include disclosure of all relevant information and public consultation) is unclear. An EIA has been conducted on the proposals for the first three berths and associated infrastructure for the new port of Lamu. However, in order to understand the full implications of the many different facets of this project and plan effectively for its development, a formal SEA should be undertaken.

2.6 Governance

2.6.1 Administrative Structure

Under the new county structure 90% of the Tana River Delta falls within Tana River County while the remaining 10% is administered by Lamu County. The statistics relating to governance and infrastructure were collected under the former District administrations and have not yet been updated. However, they present a clear picture of current conditions, which may change under the new administrations. ,

The former Tana Delta District had three administrative divisions: Garsen, Tarasaa and Kipini. The former District headquarters were in Minjila from where all development projects were coordinated. The District Development Committee (DDC), chaired by the District Commissioner, was the clearing house for all development proposals. The sub DDCs at the divisions coordinated their respective development projects and were chaired by District Officers.

The former Tana Delta District had 9 electoral wards and one constituency – Garsen. The County Council of Tana River, which was also in charge of Tana Delta district, was the only local authority in the district. Under the devolved system of governance, the number of electoral wards were reduced to 6, namely Kipini East, Kipini West, Garsen West, Garsen Central, Garsen South and Garsen North.

There are three police stations, namely Gamba, Garsen and Kipini Police stations. Police posts are six in number, which are Tarasaa, Oda, Idsowe, Hurara, Sailon and Mnazini/Kibaoni police posts. The nature of crimes reported in the base line reports ranged from petty crimes to criminal cases. There had been an increase in the number of resource use conflicts.

To enhance access to judicial services, a courthouse has been renovated in Garsen town and is operational as a magistrate's court. It operates in Garsen but is moved to Kipini or Witu on Tuesdays and Wednesdays weekly, thus the court is mobile. The High Court is located in Malindi. There are many cases which have not been determined. There is a proposal to establish a High Court in each County to enhance administration of judicial services in the country.

The chiefs and sub-chiefs ensure law and order is maintained in their respective areas. They also resolve local disputes with the help of local elders. There are peace committees which assist in dispute resolution and preaching peace among the various communities living in the Tana Delta. These committees comprise elders from each community and leaders of religious groups. This constitutes the alternative dispute resolution system.

The new constitutional order creates a county government of Tana River. The executive authority of the County government is vested in the elected Governor and the executive committee. The legislative authority is vested in the County Assembly. All functions except security, education and administration of justice have been transferred to County governments. It should be noted that more than half of Tana River County is north of the Delta, away from the shore.

Managing natural resources in the Tana Delta has been a complex affair due to many factors including weak legal and institutional frameworks and multiple and competing policies, institutions and legislations. The result is an uncoordinated approach to managing resources in the Delta. This is further marred by the overlapping and conflicting mandates of the various institutions. There are inconsistencies and contradictions between various laws and policies touching on natural resources management.

2.6.2 Gender Issues

A situational analysis undertaken as part of the SEA Scoping study showed that women undertake all the major household activities. Among the pastoralists, men are involved in herding while among the agriculturalists, very few men are involved in actual farm work yet they are the ones who control family resources. The major gender issues in the area include: heavy workload for women; exclusion of women from accessing economic assets due to traditional practices; exclusion of women from decision-making roles due to cultural practices; early marriages for the girl-child; and low literacy levels among women and girls due to preference for educating male children. Women are excluded from owning important economic assets.

2.6.3 Types and Sources of Conflicts

There are various types and levels of conflicts in the Delta. They range from family conflicts, human-wildlife conflicts, community conflicts, conflicts between communities and TARDA and also inter-ethnic conflicts. At the family level, the major conflict is between husband and wife. Inter-ethnic conflicts have been reported between the Wardei/Orma pastoralists and Pokomo farmers. TARDA has also been accused of failing to pay casual labourers. Human-wildlife conflicts were reported by majority of respondents (86.7%).

Resource use conflicts have intensified in the Delta as a result of increased pressure on the natural resources due to rapid population increase, climate change, land use conversions, insecurity of land tenure, etc. The conflicts manifest themselves in the form of wildlife – human and human – human conflicts. Human – human conflicts have been associated with competition for pasture, water and farmland. Such conflicts could be managed through designating grazing and farming zones as well as rationalizing livestock numbers against available pasture.

Tana Delta is also home to a diverse variety of wildlife. Increased human encroachment of wildlife habitats for settlement, grazing and farming have resulted in wildlife – human conflicts occasionally leading to loss of life, livestock and destruction of crops. The wildlife corridors and dispersal areas have been encroached. The LUP will propose a strategy to tackle the human-wildlife conflicts, e.g. by mapping the wildlife conservation areas and controlling movement into the areas.

PART THREE: ENVIRONMENTAL CONDITIONS

2.7 Geology and Soils

Tana River Delta falls within the Coastal Plains, one of the three physiographic zones on the Kenyan coast that rises from sea level to 200 m. The Delta has a coastal strip stretching 76 km which is protected by a 50 m high sand dune system. The geomorphology of the Coastal Plain is dominated by a series of raised old sea level terraces. Most of the coastal environment and the modern shore configuration follows the 0-5 m and the 5-15 m sea level terrace complexes (Government of Kenya, 2008).

Soils in the Tana River Delta are generally classified as Fluvisols being divided into two subgroups: eutric and vertic Fluvisols (Jaetzold and Schmidt, 1983). These are generally black cotton soils with clay, loam and alluvial deposits. They have low or moderate fertility in the hinterland where there is no influence of flooding. High fertility soils are found along the natural depressions and along the flood plains of River Tana. Their fertility is due to the accumulation of silt or clay brought about by flooding.

In the meander belt (river levee land) as a result of the old and new river courses, the soils are often stratified, comprising of yellowish–brown sands and clay deposits that are rich in Micas. The textures of topsoil range from sand to clay while the sub-soil is usually firm clay. The rate of infiltration of water into such soils varies with texture; being slow in areas with clay topsoil, and fast where sand forms the upper layer. Such soils have been described for the area between Lango la Simba and Abarfarda River where the topography is flat to gently undulating. Generally the soils in the terraces are excessively drained while those in the flood plain of River Tana are imperfectly drained (Government of Kenya, 2008).

2.8 Hydrology of the Tana River Basin

2.8.1 Physical Characteristics

River Tana is the longest river in Kenya and it drains the largest catchment in the country, extending to 96,000 km^2. (The geographical extent of the administrative area is even larger at 132,000 km^2, since it includes areas drained by ephemeral streams discharging direct to the Indian Ocean and represents 23% of the entire country). River Tana accounts for 32% of the total river runoff in Kenya (Kitheka *et al*, 2002).

The total catchment area of the Tana River Basin occupies 95,918 km^2. For water resource management purposes it is divided into 3 sub-catchments:

- Upper catchment: upstream of Kamburu, 9,349 km^2
- Middle catchment: between Kamburu and Kora Rapids, 15,873 km^2
- Lower catchment: downstream of Kora Rapids, 70,696 km^2

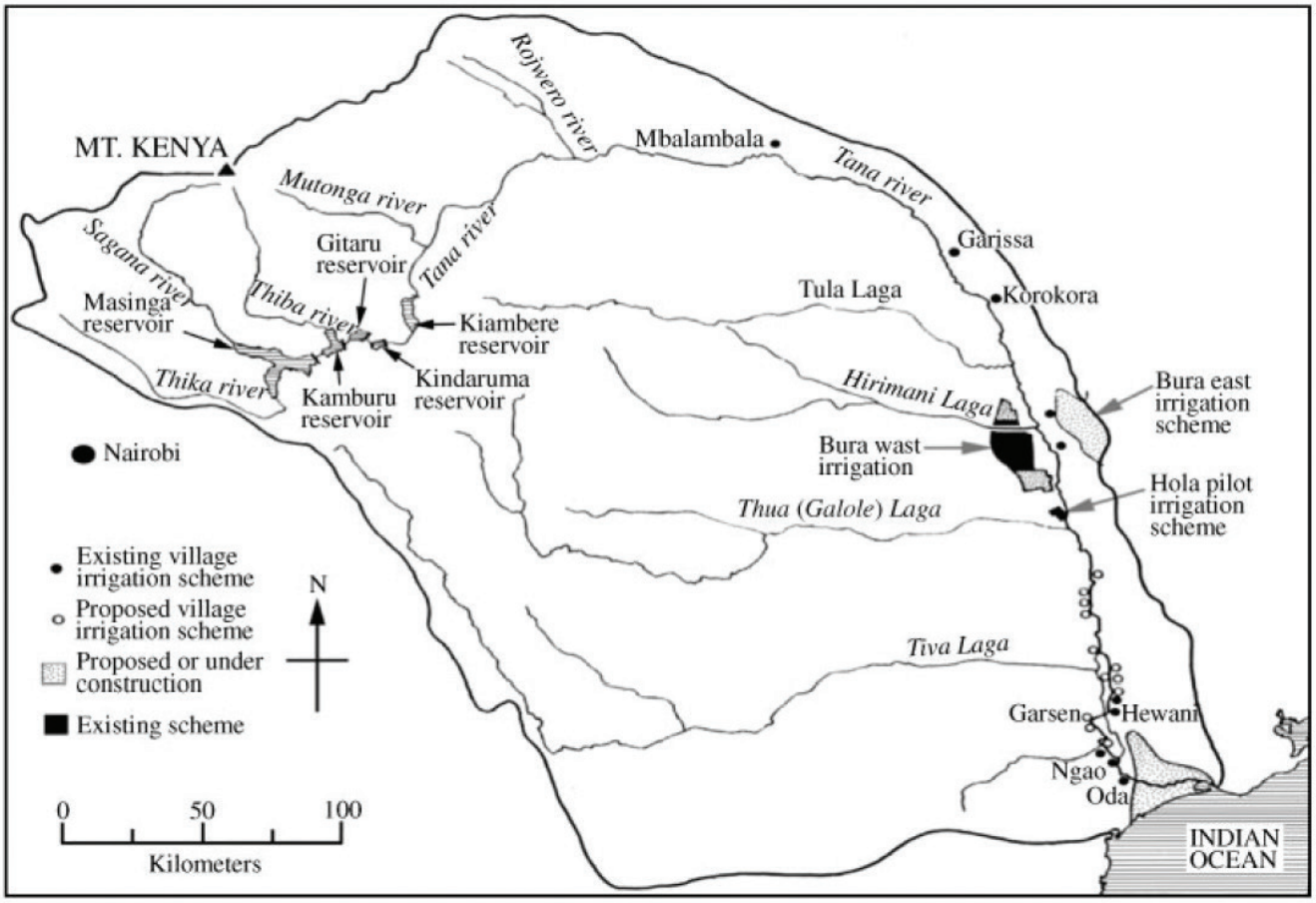
The area lying to the northeast of the Tana Delta, which drains directly to the Indian Ocean, accounts for an additional 34,000 km^2 (Kitheka *et al*, 2002).

The upper catchment includes most of the eastern slopes of the Aberdare/Nyandarua Mountains and the southwest/southern slopes of Mount Kenya (Maingi & Marsh, 2002). River Tana begins as the Sagana on the south east slope of Mount Kenya. It is joined by many other tributaries before it reaches Masinga Dam, the first of a cascade of dams and reservoirs that has been built in the Upper Catchment over the past sixty years (the Seven Forks Cascade). Rainfall varies between 2000 mm a year on the higher mountains down to 300 mm a year in the middle semi-arid reaches and then rises to 600 mm and above along the coastal belt (Maingi & Marsh, 2002).

The middle catchment of the River Tana system includes the combined catchments of the Gitaru, Kindaruma and Kiambere dams and extends from below Masinga Dam to Kora Rapids. This section receives annual rainfall ranging between 600 and 800 mm (Government of Kenya, 2008).

After Grand Falls, the Tana descends gradually through rapids underlain by basement complex of gneiss across the river valley. This basement complex is resistant to

Figure 2.5 The River Tana Catchment



Source: J.K. Maingi & S. E. Marsh, 2002

erosion. Kora Rapids form the last part of these rapids after which the river enters the flat sedimentary plains of the Lower catchment. The rapids lie at an elevation of 245m asl (Maingi & Marsh, 2002).

The lower catchment includes the area between Kora rapids and the Delta up to the sea. In this part of the catchment, there are no perennial tributaries. The Rahole River from Rahole National Reserve is the only tributary entering the Tana from the left bank. Its catchment has low annual rainfall ranging from 200 to 400 mm. On the right bank there are seasonal streams called lagas which originate from dry areas with rainfall of less than 400 mm (Government of Kenya, 2008).

The flood plain varies in width from 3 to 8 km and spreads widely, leading to water loss through seepage and evaporation. Most flow contribution in this stretch comes from upstream sections of the main river; augmented in the rainy seasons from the otherwise dry river beds of the lagas (Maingi & Marsh, 2002).

2.8.2 Surface Water

2.8.2.1 Annual Run Off

River Tana has a very variable pattern of surface runoff, dictated by seasonal weather conditions but also periodic oscillations in climate. In most years, peak flows occur during two seasons (between April and May and between November and December). These result from the onset of heavy rainfall in the Upper catchment, although localized rainfall in other parts of the Middle and Lower catchments can also contribute to high flows in the lower reaches.

The upper and middle catchments contribute around 4.47 billion cubic metres of water a year. With over 2 metres of rainfall in a typical year, the Aberdare highlands and Mount Kenya make the largest contribution to total water flows in River Tana, but these figures are deceptive because there is no accurate information on runoff in the lower catchment, even though this accounts for 73.7% of the surface area of the overall basin. Lack of adequate gauging of River Tana below Garissa is a serious constraint on proper planning of development in the overall Tana River Basin.

2.8.2.2 Average River Discharge

The amount of water that a river discharges at any given time is measured in cubic metres per second (m3/sec). In an average year, discharge at Garissa ranges from 1000m3/s in the wet season to as little as 20m3/s in the dry season, with a mean annual rate of discharge of about 51m3/s (Government of Kenya, 2008). The mean flow is significant in terms of calculating the total amount of water that is available throughout the year, especially under drought conditions. Of equal importance in environmental and social terms are the extreme events of floods and droughts.

2.8.2.3 Annual Flooding

Peak flows commonly occur in River Tana during the two rainy seasons each year. These flood events follow a standard 'hydrograph' in which the volume of water in the Tana increases rapidly to a peak within a few days of the onset of heavy rain and then declines gradually over several weeks. Highest flood discharges are recorded in the upper and middle catchment with the maximum discharge of 3568m^3/s being achieved at Garissa WRMA National Station RGS 4G01 on 21st November 1961 (Maingi & Marsh, 2002).

The cross-sectional area of any river channel is adapted to accommodate a range of flow conditions and flooding occurs when water levels reach the 'bank-full' stage. The phenomenon of flooding is an entirely natural event and plays a most valuable role in spreading silt, increasing soil fertility and maintaining floodplain ecosystems, but it is invariably treated as undesirable and as a 'disaster' where human activity and infrastructure is adversely affected. However, most people who live in the River Tana catchment are aware of the benefits as well as threats from flooding and have developed ways of coping with routine flooding. Due to the steep gradients, large flood flows in the upper reaches of River Tana affect relatively small areas of land, but in the middle reaches flood water can spread out to inundate much larger areas.

It needs to be stressed that detailed analysis of the hydrology in the Lower Tana is severely hampered by lack of adequate gauging and incomplete rainfall and flow records. The river gauge at Garsen relies on manual recording, and there have been long periods when no gauge readings were available due to flood damage.

From first principles it might be expected that the intensity and magnitude of a flood would continue to increase downstream from the site of the proposed High Grand Falls Dam but the available flow gauge data produces contradictory evidence for the lower Tana Basin. Instead of increasing in volume with the expanding catchment, the size of any given flood discharge at the Garissa Gauging Station appears to drop by around 50% by the time it reaches Hola. It has been shown that floods observed at Garissa take roughly 24 hours to reach Bura (Hughes, 1985) and by the time the flood reaches the manual gauging station at Garsen the flood records show no appreciable rise in flood flows above 200 m3/sec.

The commonly accepted explanation for this reduction in flood flows is that the lower Tana valley acts like a giant sponge in absorbing the flood water. This area

is naturally semi-arid, so that even in the rainy season significantly less rain falls than in the upper catchment. In addition, the main river channel below Garissa breaks up into numerous small water courses which merge into wetlands, swamps and marshes and this entire region soaks up the excess river flow. At its southern end, above Garsen, the dispersed waters of the flood plain gather in large lakes and then discharge through braided channels which coalesce to re-form the main river a few kilometres north of Garsen.

It has also been suggested in the Feasibility Study for High Grand Falls Dam that the upper catchment contributes very little flood flow to the Tana Delta and that flooding in the Delta is caused by discharge from the lagas on the western bank of the river below Hola.

The issue of what happens to flood water recorded at Garissa but missing at Garsen was identified as a subject for study in the SEA, together with another critical question about the extent to which the broad floodplain of the middle and lower Tana acts as a reservoir, attenuating (i.e. absorbing) the peak flow and converting this to extended periods of high river flow which is then capable of supporting sustained flooding of large parts of the Delta for weeks on end.

These issues were investigated and the results were reported to a scientific conference on the Tana River held by NEMA and the University of Nairobi in February 2014 (Nelson and Odeny, 2014).

The provisional findings from this review confirm that, contrary to the view expressed in the High Grand Falls Dam feasibility study, the flow conditions in the Tana Delta do mirror very closely those in the upper catchment, as shown in Figure 4, Annex 1. In addition, inspection of the flood alleviation bridges/culverts under the Garsen-Witu Road has confirmed that these very large structures (typically 40 metres wide and 4-6 metres high) do pass substantial volumes of flood water – as evidenced by serious undermining of one of these structures. Once the floodwaters extend beyond the banks of River Tana they are dispersed over a wide area which is effectively dammed by the Garsen-Witu road embankment. Enormous volumes can be stored upstream of this barrage and released through the culverts as well as the main river channel. Consequently a rise of only a few centimetres may represent a major increase in flood volume without being registered on the staff gauge at Garsen.

2.8.2.4 Exceptional flood events

Exceptional flooding (and drought) occurs periodically, for reasons that are not fully understood but they are linked to cyclical sunspot activity and the reversal of ocean currents in the Pacific, known as the El Nino and La Nina effects (Karanja & Mutua, 2000). This cycle of events has a recurrence of roughly 7-10 years. Climate modelling predicts that these changes may become more pronounced in the future, leading to increased rainfall (Nakaegawa, 2012).

Flood and drought conditions play a critical role in the economy and environment of the Tana River Basin and are a major contributor to social issues including poverty and insecurity. This means that, in many ways, they are as significant as the annual mean figures that are used to describe the hydrological characteristics of the Basin and its sub-catchments. The most recent floods occurred in 2013 during the long rains season and also in 2006/7. However, the El Nino associated floods of 1997/98 remain in the memory of residents of Garissa and beyond, because they were associated with extensive damage to infrastructure and loss of livelihoods.

2.8.2.5 Dry Weather Flows

The marked seasonal patterns of rainfall are separated by periods with little or no rain during which river flows steadily decline. In particularly dry years the flow at Garissa may drop to as little as 20 cubic metres per second (M3/sec). Within the delta area below the Primate Reserve, this leads to the drying up of many channels, oxbow lakes and wetland areas. Droughts are less prevalent in the Delta than flooding, but they cause extreme hardship and lead to increased social tension and insecurity when pastoralists compete with farmers for access to grazing and water.

2.8.2.6 Changes in Water Availability and River Flow

Many reports refer to the fact that water availability is decreasing in the Tana River Basin. This situation arises, not because of a decline in the quantity of water, but due to increasing demand.

Increasing water demand: The primary cause of the increase in demand for water is growing population and related livelihood needs.

Water allocation: The principal uses of water in the Tana River Basin are for hydro-power generation, irrigation and public consumption. Only a small volume of water used in power generation is transferred outside the basin. In addition to meeting demands within the Tana River Basin, water is transferred to other areas e.g. to Thiba.

Dam construction: A series of dams (the Seven Forks cascade) was constructed between the 1960's and 1980's in order to provide for hydro-electric power generation and water storage. The first three dams

(Kindaruma, Kamburu and Gitaru) had small reservoirs and were built primarily to create the necessary head of water to generate electricity from direct river flow. However, the Masinga Dam, completed in 1981, and the Kiambere Dam had much larger storage capacities, enabling them to act as regulating reservoirs which store water for release in the dry season. Power generated by this cascade system accounts for more than 60% of the total electricity output of Kenya. Five additional potential dam sites have been identified in the Tana River Basin, including the Grand Falls dam on which construction work is imminent.

Impacts of upstream storage: Creation of dams in the upper basin has had a measurable impact on downstream flows in the lower River Tana. In general, construction of the two regulating reservoirs has augmented the dry weather, or minimum, flow while reducing peak floods. Floods during the month of May have seen a reduction of 20% since the dams were completed and the variability of monthly discharges in River Tana has been drastically reduced. Vegetation characteristics have been affected by a reduction in the average duration of flood events (from 8.2 to 5.2 days). In addition the meandering rate (rate of movement of the river channel due to cutting of meanders) has fallen since the Masinga Dam was constructed (Maingi & Marsh, 2002).

Another significant change brought about by the construction of the Seven Forks reservoirs has been the reduction in sediment load in the Lower Tana River by an estimated 56% from 12 million tonnes a year to 6.8 million tonnes a year. This drop is likely to have significant long term effects on the fertility of the lower floodplains which no longer receive an annual 'top-dressing' of silt. It is reported that loss of sediment has already caused coastal changes at Kipini and Ungwana Bay through erosion of the beaches (Kitheka *et al*, 2002).

2.8.3 Ground Water

Ground water conditions vary widely according to the basic geological characteristics of the basin. According to the Water Resources Management Authority (2009) the aquifer characteristics of the Tana River Basin are classified as follows:

2.8.3.1 Upper Tana Region

'Intergranular' and 'fracture-type' aquifers in this region generally produce good quality water with yields varying between 5 to >30 m^3/hr.

2.8.3.2 Middle Tana Region

Within this semi-arid to arid zone, the aquifers are localized and typically poor. This area extends from Tharaka, Kitui, Mwingi and parts of Yatta Districts.

2.9.3.3 The Lower Tana and Coastal Belt

There is extensive groundwater storage in this aquifer. Depending on geologic formations, these aquifers have the potential to provide the most strategic ground water reserves, which can be accessed through springs, shallow wells and boreholes.

2.8.4 Water Quality

Water quality of the basin is generally declining, due to point and non-point pollution. The main point sources of pollution in Tana include agro-based industries (coffee and tea factories); livestock based industries (slaughter houses, milk plants and tanneries); and sewerage works in large towns. The main non-point sources of pollution include pollutants from land degradation due to deforestation and erosion; encroachment into wetlands and riparian lands; and poor agricultural and farming practices (Emerton, 2003).

Quantification of water quality and the extent of pollution from these sources are difficult to determine. This is because information and data on the status of water quality is insufficient.

2.8.4.1 The Upper Tana

This part of the catchment is characterized by catchment destruction, high population, higher number of agro-based factories and urbanization. These contribute to quite substantial pollution of surface water resources by tea factories, poor sanitation and wildlife in the forest. Groundwater quality can be adversely affected by high fluoride levels (Government of Kenya, 2008).

2.8.4.2 The Middle Tana

The middle reach experiences aggressive agricultural practice and overstocking, leading to catchment degradation and consequent higher erosion. Other pollution emanates from quarrying activities, sand harvesting and farm chemical wastes. Erosion and sediment transport and deposition are major pollutants in this reach in addition to similar pollutants of the upper Tana. Groundwater contains pockets of heavy metals and fluoride (Emerton, 2003).

2.8.4.3 The Lower Tana

This part of the catchment is characterized by water scarcity in time and space with high evapo-transpiration rates which places a heavy reliance on groundwater for local drinking water supplies. Groundwater faces challenges of salinity (fluorides and iron) due to the nature of rock formations. Other challenges include sea water intrusion, tourism by-products, poor domestic water disposal and poor sanitation (Government of Kenya, 2008).

2.9 Hydrology of the Tana Delta

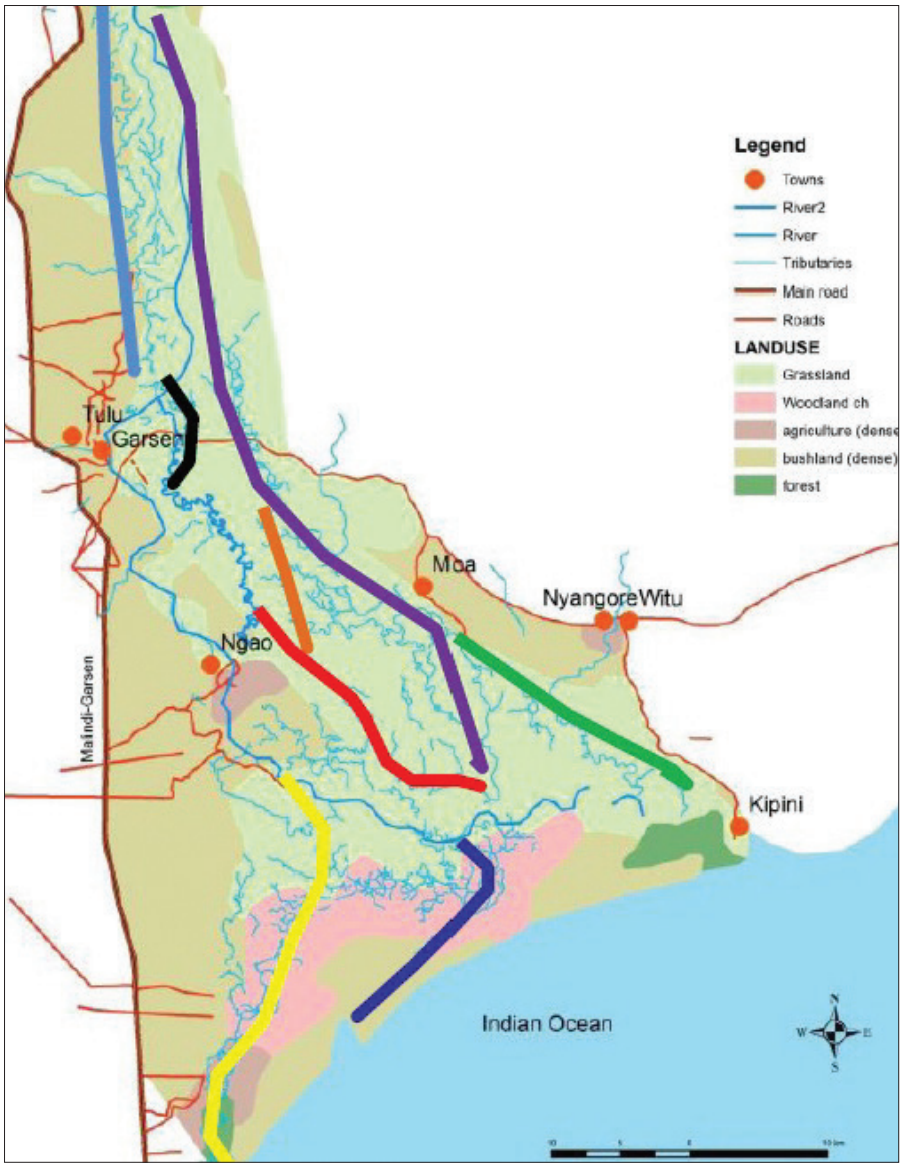
2.9.1 Historic and Current River Channels

The floodplain of the Lower Tana River gradually widens from 2 kilometres below the Tana Primate Reserve to reach its maximum breadth of 60 kilometres behind the coastal dunes. Historically the main river channel was free to migrate across the whole floodplain, through a continuous process of meandering with occasional abrupt changes in course, caused by major breaches of the river banks in times of flood (Hamerlynck *et al*, 2010).

At least four former courses of the Tana can be traced in the residual water courses and oxbow lakes which lie within the delta. The oldest is thought to be the channel which flowed through Vumbe and Lango la Simba to enter the sea via the Ozi River (Nyunja *et al*, 2013). Each change of the river course has a dramatic impact on land use, navigation and the location of settlements, with important ramifications for the resident population within the Delta (Nyunja, *et al*, 2002).

In the 1860's, a navigation channel was dug to connect Belazoni (along River Tana) to Kau (on the Ozi) and after a particularly heavy flooding event at the end of the 19th century, the river broke through and this artificial connection widened and became the principal mouth (Hamerlynck *et al*, 2010). The original estuary of Mto Tana now only functions during periods of flooding. Until the late 1980s, freshwater used to flow into the old delta through some of the numerous channels but these have since been blocked by small dams constructed by Pokomo farmers for local irrigation of their fields (Bennun and Njoroge, 1999).

Figure 2.6: Historic Channels of the River Tana



In the 1960's, a new breakthrough occurred when River Tana cut through the protective sand dunes in the central area of the delta and created an outlet to the ocean at Shekiko. This part of the delta now consists of a network of tidal creeks, with extensive mangrove cover, interspersed with seasonally flooded grassland dotted with palms and acacia. Some of the creeks have been cut off from River Tana, but Matolo, the most western creek, has still a functional connection to the main river course (Bennun and Njoroge, 1999).

Within the last 30 years, two significant events have occurred, which now control the Tana River channel above Garsen. These were:

1. The construction of the first stage of the Tana Rice Irrigation Scheme, which included construction of new water intakes and a new channel - the 'dug river', and,
2. Construction of the new Garsen Road Bridge over the River Tana, together with the raising of the Garsen-Witu Road on an embankment across the floodplain.

The main consequence of both activities is that River Tana can no longer migrate freely across the floodplain above Garsen. Instead, it is confined to a westerly channel by the Idsowe bridge. This has led to the gradual build-up of the river bed and levees to the point where the river is almost two metres above adjacent land levels. A marked gradient now exists from west to east, between the current river channel, which lies at around 15 m asl, to the course of the former Lango la Simba which is at 10m asl. This was described by Ecosystems Ltd in 1983 as a high potential risk for a disastrous flood, and the conditions have worsened since.

2.9.2 Significant Flood Events in Tana Delta

There is clear evidence, based on local knowledge, that the frequency of shallow annual floods has declined since the seven forks cascade scheme was constructed, and a double annual flood event is now rare. However, major floods still occur in the Delta and the frequency may be increasing with the onset of climate change. Floods are essential to the maintenance of livelihoods in the Delta but they also cause widespread damage and pose a threat to life of animals and humans.

2.9.3 Irrigation Schemes

Although deltas are highly dynamic environments it is possible to modify their character by realigning and canalizing rivers. The history of engineering work in the Tana Delta contains many examples of schemes that have failed due to exceptional force of flood events. The record of development within the Lower Tana River and Tana Delta over the last 60 years is a litany of poorly planned engineering and irrigation schemes based on inadequate data with inadequate scientific knowledge, misleading economic evaluations, a disregard for human welfare and management failures and incompetence. This situation has to change.

The first major irrigation schemes were introduced in the Tana River Basin between 1960 and the early 1980s. Initially, it was anticipated that the basin had a potential of 132,000 ha for irrigation. However, due to a combination of poor design and management, and serious flood damage, many of the schemes failed.

2.9.4 Water Demand

2.9.4.1 Irrigation

In 2000, the total water demand in the Tana River Basin was estimated to be 268 million m^3 per year, representing 6% of the annual flow (Government of Kenya, 2012). However, if all the irrigation schemes constructed by 2000 had been operating to their full design potential, total water abstraction from River Tana would have been equivalent to about 20% of its annual discharge and this level of development could not have been sustained with the amount of storage in the catchment.

Vision 2030, Kenya's long term development blue print for the future, has set a target to increase the area under irrigation and drainage from 140,000ha to 300,000ha with priority to food production, industrial and fodder crops in the commercial and semi-commercial sectors (Government of Kenya, 2007).

The present irrigation area in the Tana catchment is nominally 64,425ha, which is 45% of the land under irrigation nationally. It consists of both small and large scale irrigation. Most small scale irrigation is practised in the upper and middle reaches of the Tana by individual farmers although there are two large schemes; the Mwea Irrigation and lower Tana basin schemes which are under the control of the National Irrigation Board and TARDA (Government of Kenya, 2012).

The river and its floodplain provide opportunities for cultivation in the Lower Tana Basin, mostly through flood recession and limited traditional irrigation. Some limited river fishing occurs mainly focused on ox-bow lakes which are flooded and replenished during the seasonal river floods. Lower Tana irrigation schemes faced many management and water supply constraints in the early 90s but are now being revived. New management structures are being put in place and rehabilitation is in progress although many commentators remain critical of the rate of progress and lack of capacity.

2.9.4.2 Hydropower

Electricity generated from hydro-power stations constitutes more than 60% of Kenya's total electricity

supplies and the Seven Forks cascade dams collectively have more than 400 MW installed capacity. However, power production is seriously affected by low flows in the dry seasons and the Government is taking urgent action to promote new hydro-power development through the High Grand Falls (HGF) Project, together with geothermal energy in the Rift Valley and wind energy. Thermal power is also produced in Mombasa and Nairobi. However, the HGF dam is intended to be a multi-purpose project which will not only provide a massive boost in power, but will also supply essential water supplies to Nairobi, the North Eastern counties and the LAPSSET corridor, meet the needs of expanding irrigation, and safeguard livelihoods.

2.10 Future Water Supply and Demand

2.10.1 Projected Water Availability and Demand

According to the draft National Water Master Plan, April 2012, renewable surface water resources in the River Tana basin were estimated to be 5,858Mm^3/yr in 2010 and are projected to increase to 7,261Mm^3/yr by the 2030. Similarly, renewable groundwater resources were estimated to be 11,671 Mm^3/yr in 2010 and are projected to decrease to 11,589Mm^3/yr by 2030. The demand from surface water is estimated to be about 801Mm^3/yr while that of groundwater is estimated from borehole abstraction data as about 68 Mm^3/yr.

2.10.2 Planned Developments

As discussed in section 2.2.6, two of Kenya's main flagship projects set out in Vision 2030 are located in the Tana River Basin; these are the development of the High Grand Falls Dam and realization of the new Lamu (Magogoni) port and LAPSSET corridor infrastructure. Both projects have the capacity to transform Northern Kenya but they also pose grave challenges to existing livelihoods and the environment of the Lower Tana Basin and Delta. In addition to the uses already described water will be needed in the Tana River Basin for a wide range of domestic and industrial functions and to maintain the integrity of the Tana River Delta Ramsar site.

2.10.3 Summary of Water Issues

The main water source in Tana Delta is River Tana. In the dry seasons, villages which are far from the river rely on excavating small pits in dried up channels and depressions. But even this water source is dependent on recharge from the main river and from surface floods during the rains (Government of Kenya, 2012).

2.10.4 Water Consumption

Water is required for crop irrigation, livestock and domestic consumption, and natural conditions of water supply have deteriorated in the last forty years as a result of impoundments in the Upper Tana Catchment. Research for the SEA has shown that flows in River Tana have historically maintained a minimum monthly mean of 60m^3/second at Garsen (Idsowe Bridge), with levels dropping to 45 or 30m^3/second in only a few months in extreme drought years. Much of this water is distributed though minor channels across the lower floodplain where it sustains wetlands on which local communities depend for their livelihoods as well as sustaining the rich biodiversity.

2.10.4.1 Domestic Consumption

Existing levels of water consumption remain very low in terms of permanent abstraction since waste water is returned naturally to the system. Human consumption of water is restricted by the capacity of women and children to collect it. If it is assumed that the average abstraction per person for all purposes is 20 litres (Isola Figures) (Mati, 2006) this equates to a daily demand of 2.04 million litres (2,040 m^3/day). This compares with average consumption per head of 150 litres/day in Nairobi.

2.10.4.2 Agriculture

Most farming in the Delta relies on rainfall during the wet seasons, receding floodwaters and natural groundwater percolation. Consequently it is hard to attribute a precise value to water uptake. It is reasonable to assume, however that in a typical 90 day period for crop production, plants will absorb soil water at a rate of 100 mm per month equating to 0.33m^3 per square metre (Emerton, 2003). Cropping takes place on 6,204 ha so the estimated water demand is 227,500m^3/day.

2.10.4.3 Livestock

The daily water intake for cattle in rangelands is in the region of 12-20 litres although this is for beef cattle and dairy cows require 50-100 litres when lactating (Emerton, 2003). Daily consumption will be in the region of 4,240m^3/Day (assuming 15% are milking cows) (Emerton, 2003). This estimate deals only with direct water consumption. The amount of water taken up by grass and plants and eaten as forage by livestock and wild herbivores is likely to be on a comparable level to agricultural cropping (Government of Kenya, 2008).

2.10.4.4 Water and the Environment

Water is the source of all life within the Delta and a substantial amount of the water reaching the Delta is absorbed by soils and vegetation or is lost through evaporation.

There has been remarkably little field research into the hydrological conditions in the Tana Delta although this is now starting to be rectified, where funds allow, by a team of scientists (Kenweb) coordinated from the National Museum. In the absence of data it has been necessary to

Table 2.4 Evapotranspiration from Floodplain Grassland and Wetland Farming Areas in a Dry Month

Rate of evapotranspiration	m^3 per m^2	m^3/Hectare	m^3/month/63,100 Ha	Flow rate m^3 equivalent per day	Discharge m^3/sec
20mm per month (30 days)	0.12	1,200	75,720,000	2,442,581	28.3
180mm per month (30 days)	0.18	1,800	113,580,000	3,663,871	42.4

Source: Tana Delta SEA, 2014

Table 2.5 Evapotranspiration from all Areas of the Floodplain in a Dry Month

Rate of evapotranspiration	m^3 per m^2	m^3/Hectare	m^3/month/63,100 Ha	Flow rate m^3 equivalent per day	Discharge m^3/sec
20mm per month (30 days)	0.12	1,200	126,720,000	4,087,742	47.3
180mm per month (30 days)	0.18	1,800	190,080,000	6,131,613	71.0

Source: Tana Delta SEA, 2014

explore the relationship between biodiversity and water supply using first principles and limited observation.

The Delta experiences two very distinct climatic seasons based on rainfall. During the short and long rains most parts of the Delta receive some rainfall in addition to recharge of the floodplain soils by high river levels and periodic flooding. However, in some wet seasons rainfall and flood levels remain low and both the vegetation and wildlife in the Delta are seriously affected if these conditions are subsequently followed by drought. Following the end of the rains, vegetation growth continues for one or two months based on the uptake of water from the natural soil reservoir but soil moisture reduces as evapo-transpiration increases in the very hot dry season. Even in normal dry seasons, the high temperatures in the Delta lead to rapid evaporation and wilting conditions for grass and other vegetation. Poor growth linked with over-grazing can rapidly remove much of the surface vegetation leaving bare earth across large parts of the floodplains and in the adjacent terraces.

The amount of water used by grassland and other vegetation can be estimated using the FAO standard for water demand in crops, since the reference datum is based on trial plots of good quality grass cover as the reference point for evapo-transpiration. In arid lands within the tropics good quality grass sward typically transpires between 4-6mm of water per m^2 per day or 120-180mm per square metre per month. These figures equate to the loss to the atmosphere of between 1,200-1,800 m^3 per hectare per month.

The floodplain grasslands of the Delta cover 50,800 ha, while wetland farming areas (converted from floodplain grassland) occupy a further 12,300 ha. These two areas constitute the most important farming and livestock grazing areas of the Delta and cover an area of 631 km^2. Table 3.4 shows how much water is evaporated or transpired from this area in a typical dry season month. The volume of water lost from the Delta to the atmosphere ranges from the equivalent of 28-42 m^3/sec. However, the two land classes included in Table 2.4 form only part of the area of the floodplain which is recharged from the River Tana. To complete the picture it is necessary to add Riverine Forests (32,300 hectares), Mangrove (8,400 ha) and areas of open water (1800 ha). When these are added to floodplain grassland and wetland farming the total area of the floodplain which is recharged from the river rises to 1,056 km^2. Table 2.5 shows the total rates of evaporation and transpiration range between 47 and 71 m^3/sec in the dry seasons depending on temperature and evaporation rates.

Comparison of the mean discharge in the River Tana and mean evapo-transpiration from the floodplain show that these lie in the same range, which implies that most of the water entering the Tana Delta through normal river flows is absorbed and utilised by the natural vegetation and farming activities. These calculations are supported by the reports from local people that fresh water flows cease in the lower parts of the main Ozi branch during the dry season to be replaced by the backflow of brackish and saline water from the sea.

In summary, the water uptake by vegetation and evaporation in the floodplain lies between 4 and 6 million m^3/day, (47-71m^3/sec) representing most if not all of the River Tana flow through the Delta. This figure therefore represents the minimum flow that is required to safeguard the Delta's rich biodiversity, land uses and cultural heritage and should be adopted as the 'environmental reserve' – meaning the minimum amount of water that should flow to the Delta, regardless of the demands and uses for water upstream.

2.10.5 Water Sources

The main supply to the Tana Delta is provided by the River Tana, augmented by occasional flash floods and discharges from the ephemeral streams and rivers called Lagas. Ground water is exploited by the local population, especially in areas that are remote from the permanent river channels, but all ground water is ultimately recharged from the river and annual flooding.

The River Tana divides below Idsowe into two channels – the 'Main' river which now takes only about 40% of the flow and the newly established eastern channel, the Matomba Brook, which takes around 60% of the flow. The volume of water in the main river in dry months is too small to sustain the level of farming activity previously undertaken (due to salt water incursion at high tides). Water supply to the central wetlands is adequate except in drought conditions.

The management of water resources within the Delta is very difficult for two reasons. Firstly the flow in the River Tana is dictated by seasonal variations but also levels of abstraction upstream; and secondly, the physical direction of flows to different parts of the delta is dependent on the prevailing structure of the river channels and any attempts to engineer alternative routes using canals are liable to be destroyed by floods.

In simple terms the existing water balance in the Tana Delta has already dropped below its natural state with the construction of upstream dams and water abstraction points. Continued maintenance of the Primate Reserve and the Tana River Delta Ramsar site, biodiversity, livelihoods and culture is dependent on maintaining an average monthly flow in the River Tana at Garsen of 30-60m^3/second.

2.10.6 Changes in River Morphology and Discharge

The volume of the river has been declining at an alarming rate due to the activities upstream, This has resulted in reduced water availability for communities and loss of biodiversity. Although the decline in river discharge is principally due to dam construction upstream, it can also be attributed to climate change, unsustainable use of water and rise in demand for the water. Construction of dykes for the TARDA rice project in the Delta has also resulted to communities in the area being completely deprived of a source of water and livelihoods. On the other hand, the Delta has been affected by increased recurrence of severe floods. Bursting of the banks of the Tana has led to destruction of infrastructure and settlements in the Delta. Infrastructure for the TARDA irrigation project, for instance, was destroyed by the 1997 El Niño floods. Flooding has also contributed to siltation of oxbow lakes and river beds. The impact of flooding has been more visible because of increased settlements in the floodplains. The changing course of River Tana has also had undesirable impacts on the communities in the Delta, although most recent changes have been stimulated by human intervention.

This analysis has used the best available information to understand the hydrology of the Lower Tana, quantify future water demand, and calculate the 'environmental water reserve'. The initial findings point to the need for detailed further studies and research. In particular, further information is needed about:

- The possibility of silt discharge from High Grand Falls Dam – to offset the accumulation of silt in the dams and reduction in silt deposition in the Tana Delta.
- High Grand Falls Dam SEA - The status of this document needs to be identified and full discussions undertaken with the authors, leading to the disclosure of all relevant information and the process of public consultation which is a fundamental requirement of any SEA.
- Levels of assurance on flood discharges - Proposals to introduce water resource management rules, including provision for the release of artificial floods, need to be investigated in depth and formalized through appropriate legal procedures.
- Effects of water transfers and off-channel water diversions - All plans for transferring water outside the Tana River Catchment need to be subject to full environmental assessment. Given the cumulative nature of the proposals this assessment should be undertaken as an SEA or Cumulative Environmental Impact Assessment.

2.11 Climate Change

In the last fifty years, human development in the Tana River Basin, including dam construction and irrigation, has started to impact significantly on natural processes, while current research shows that global warming and climate change is likely to accelerate change in the next half century (Nakaegawa *et.al*, 2012).

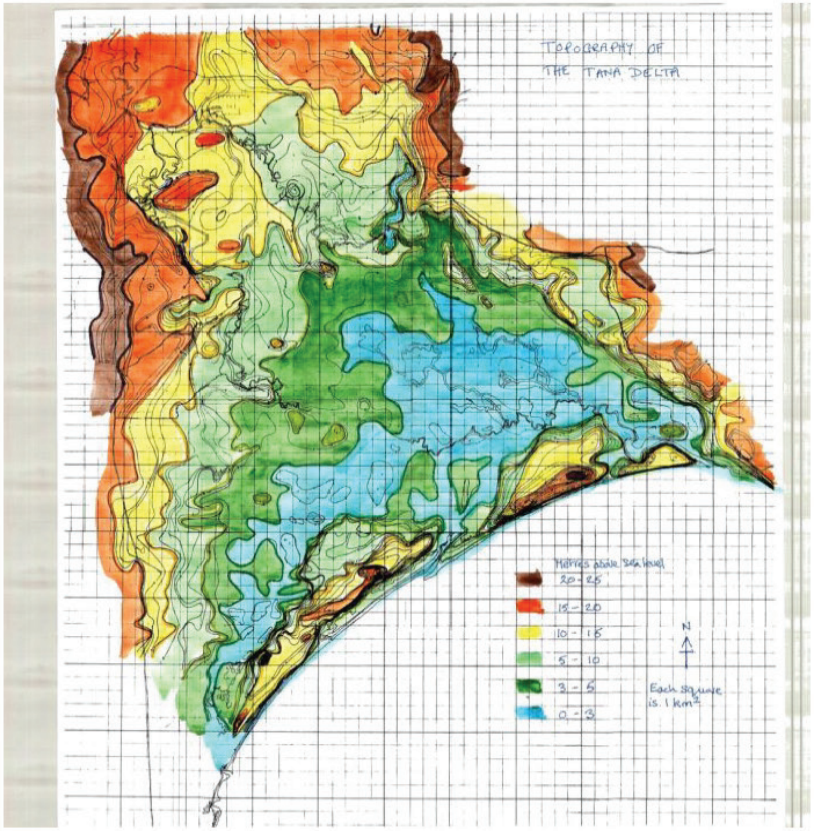
Preliminary research on the potential impact of climate change indicates increased evapotranspiration and potentially higher rainfall in the basin. This would accentuate the effects of floods and droughts. Further research will be needed to assess the likely significance of climate change within the Tana Basin but an initial exercise was undertaken as part of the SEA to produce a terrain model of the Delta, using the information on ground level heights recorded by Google Earth. Figure 2.7 shows the completed contour map in which height intervals have been extrapolated from over 2,000 point sources to yield 1 metre contours. Figure 2.8 shows the area that is potentially vulnerable to sea level rise.

Figure 2.7 Manually Plotted One Metre Contours for the Tana Delta, Ortho-corrected and Geo-referenced Using ESRI GIS

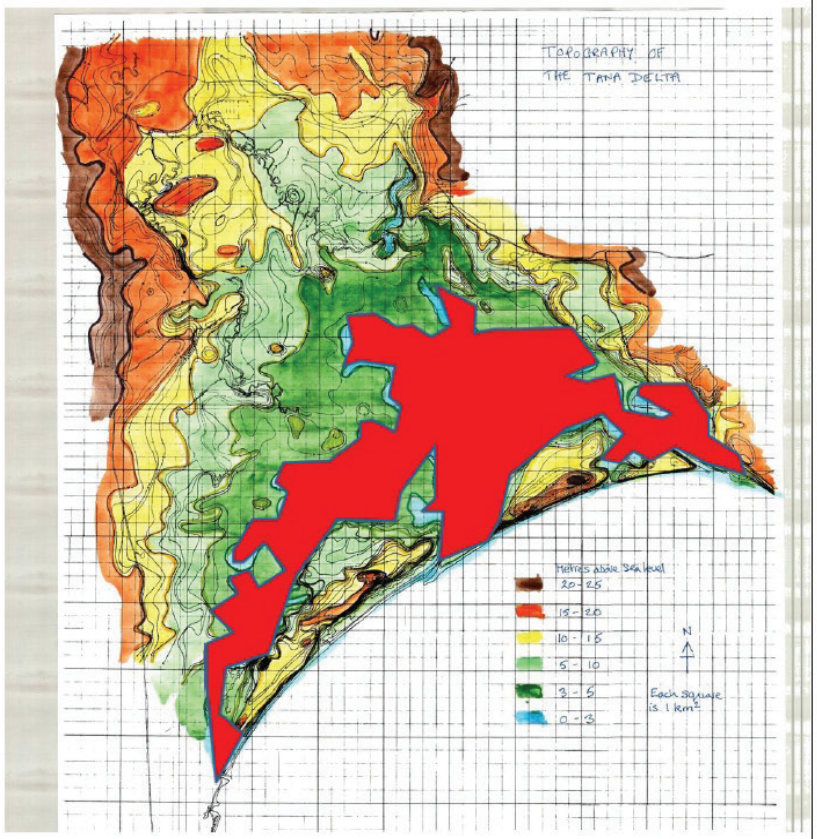
Source: Tana Delta SEA, 2014

Figure 2.8 Areas Potentially Affected by Sea Level Rise in the Period to 2100

Shaded contour map (3-5 metre bands)of the Tana Delta



Area vulnerable to Flooding from 1-3 metre rise in sea level.



Source: Tana Delta SEA, 2014

Although this zone extends from below mean sea level to 3 m asl, most of the area shaded red lies in the range 0-1m asl. Much of the land is already affected by salt water incursion as a result of tidal surges which carry sea water up to 30 kilometres upstream from the mouth of the River Tana.

PART FOUR: BIODIVERSITY

2.12 Biodiversity Characteristics of the Tana River Basin

2.12.1 The Upper Tana Basin

The upper River Tana catchment is a very important biodiversity hotspot. For example, Mount Kenya's upper parts are protected as a National Park while the lower slopes are protected as a Forest reserve. The site is also recognized as an Important Bird Area (IBA), an Endemic Bird Area, a Biosphere Reserve and an Alliance for Zero Extinction (AZE) site. Other key Important Bird Areas found in the upper catchment include the Aberdare Mountains (Forest Reserve and Aberdare National Park), the Kikuyu Escarpment Forests, Kianyaga Valleys and Mukurweini Valleys. The Aberdare Mountains, Mount Kenya, Kikuyu Escarpment forests and Mwea National Reserve are protected areas.

Biodiversity in the upper catchment is under pressure from a wide range of threats: increasing agricultural pressure, forest degradation e.g. from increasing demand for fuelwood, forest fires, lack of resources to implement biodiversity management plans, uncoordinated resource management strategies (e.g. multiple government conservation agencies pursue conflicting sector policies), human-wildlife conflicts, climate change, uncontrolled subsistence hunting e.g. in Masinga dam, dam construction (Government of Kenya, 2008).

2.12.2 Biodiversity of the Middle Catchment

The key biodiversity rich area in this segment of the basin is the 3,200 km^2 Meru Conservation Area which is a complex of protected areas along River Tana that includes the adjacent Bisanadi and Mwingi National reserves, the Kora National Park, and Meru National Park (Government of Kenya, 2008).

The two parks and the two national reserves constitute an important conservation area in Kenya which is the second largest conservation area after the Tsavo East and Tsavo West area and are perhaps one of the remaining true wilderness areas in Kenya and the world (Bennun and Njoroge, 1999). The protected areas hold substantive populations of large mammals, including the threatened African Elephant, cheetah and lions (Bennun and Njoroge, 1999). However Black Rhinoceros and the introduced White Rhinoceros have virtually been wiped out by poachers (Bennun and Njoroge, 1999) while Grevy's Zebra only remains in Meru National Park (Government of Kenya, 2008). At least 280 bird species have been recorded in the conservation area. Meru National Park is designated as an Important Bird Area (IBA). This site hosts the globally threatened Hinde's Babbler and five regionally threatened bird species (Bennun and Njoroge, 1999). The area has a rich floral diversity. For example some 720 plant species have been recorded in Kora National Park with 50 of them being endemic to the park (Bennun and Njoroge, 1999).

Another biodiversity hotspot in the mid Tana River Basin is Arawale National Reserve in Garissa, which borders River Tana on one side. It was set aside to protect the endangered Hunter's hartebeest or Hirola Other globally threatened species found in the reserve include Grevy's Zebra, African Wild Dog, Cheetah and African Elephant. The reserve also hosts reticulated giraffe, lesser kudu, buffalo, hippos and crocodiles (Bennun and Njoroge, 1999).

Biodiversity in the mid Tana Basin is under threat, including from: encroachment by pastoralists, rampant poaching particularly of elephants and rhinos and probably other wildlife, and human-wildlife conflicts (Outman, 2004).

2.12.3 Biodiversity of the Lower Tana

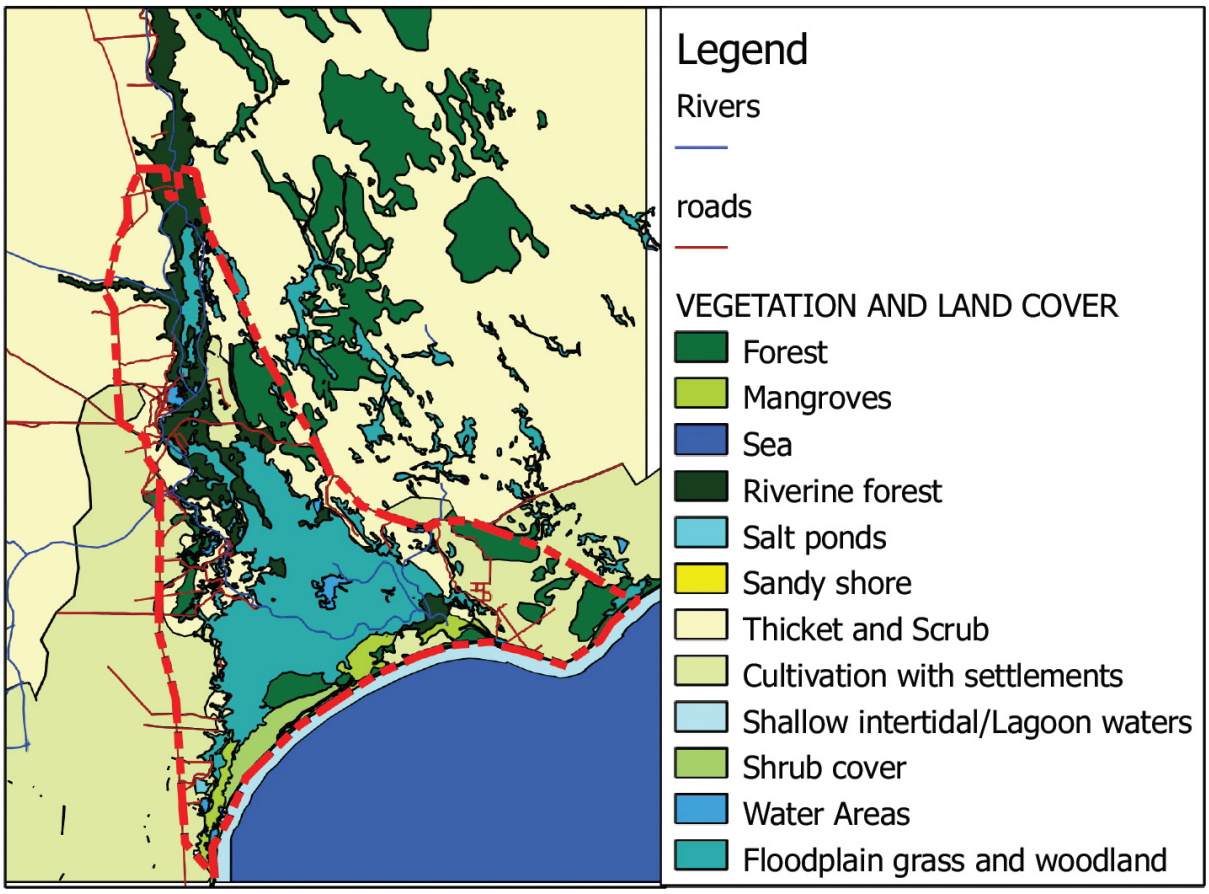
The Tana River Delta is an Important Bird Area (IBA); a Ramsar Site, a Key Biodiversity Area (KBA) and a Global Biodiversity Hotspot and is also part of the Coastal Forests of Eastern Africa Hotspot.

The natural resources of the Tana Delta include its soils, vegetation and wildlife on which many economic activities are based. A rich mosaic of habitats makes up the Delta, including riverine forest, oxbow lakes, lakes, swamps, open water, river channels, mangrove and grassland (See Figure 2.9). All of these habitats depend on the continuing flow of the River Tana.

In recent decades the number of some larger mammals (Buffalo, Giraffe, Waterbuck and Zebra) has declined due to increasing competition over grazing land with livestock, the spread of human settlement which has intruded on traditional migratory routes (from Tsavo East National Park and the North Eastern rangelands to the Delta) and in the case of aquatic species like Hippopotamus from the loss of habitat (See Table 2.6). Other species have actually increased in numbers between 1993-2003 but no more recent data is available (Albergel *et al*, 2012).

The most iconic of the Delta's wildlife – the Red Colobus and Crested Mangabey monkeys – live in dense riverine

Figure 2.9 Distribution of Vegetation and Land Cover in the Delta (2010)



Source: Tana Delta Land Use Plan, 2014

forest and are hard to count. Although the population appears to be stable the habitat is under constant threat from tree clearance (Albergel *et al*, 2012).

Table 2.6 Wildlife Population in the Tana Delta

Species	1993	1996	2002
Buffalo	8,644	1,884	1,518
Eland	736	78	-
Elephant	122	255	239
Grant's Gazelle	2,325	3,846	3,537
Gerenuk	2,345	3,022	4,356
Giraffe	3,799	1,315	1,218
Hunter's Hartebeest	407	19	-
Lesser Kudu	1,259	883	2,098
Oryx	1,802	2,178	1,019
Ostrich	1,414	1,044	419
Topi	5,679	255	-
Warthog	1,666	2,590	2,677
Waterbuck	1,201	608	139
Plains Zebra	2,461	2,355	1,538
Grevy's Zebra	38	37	-

Source: Kenya Wildlife Service

2.12.4 Wildlife Corridors

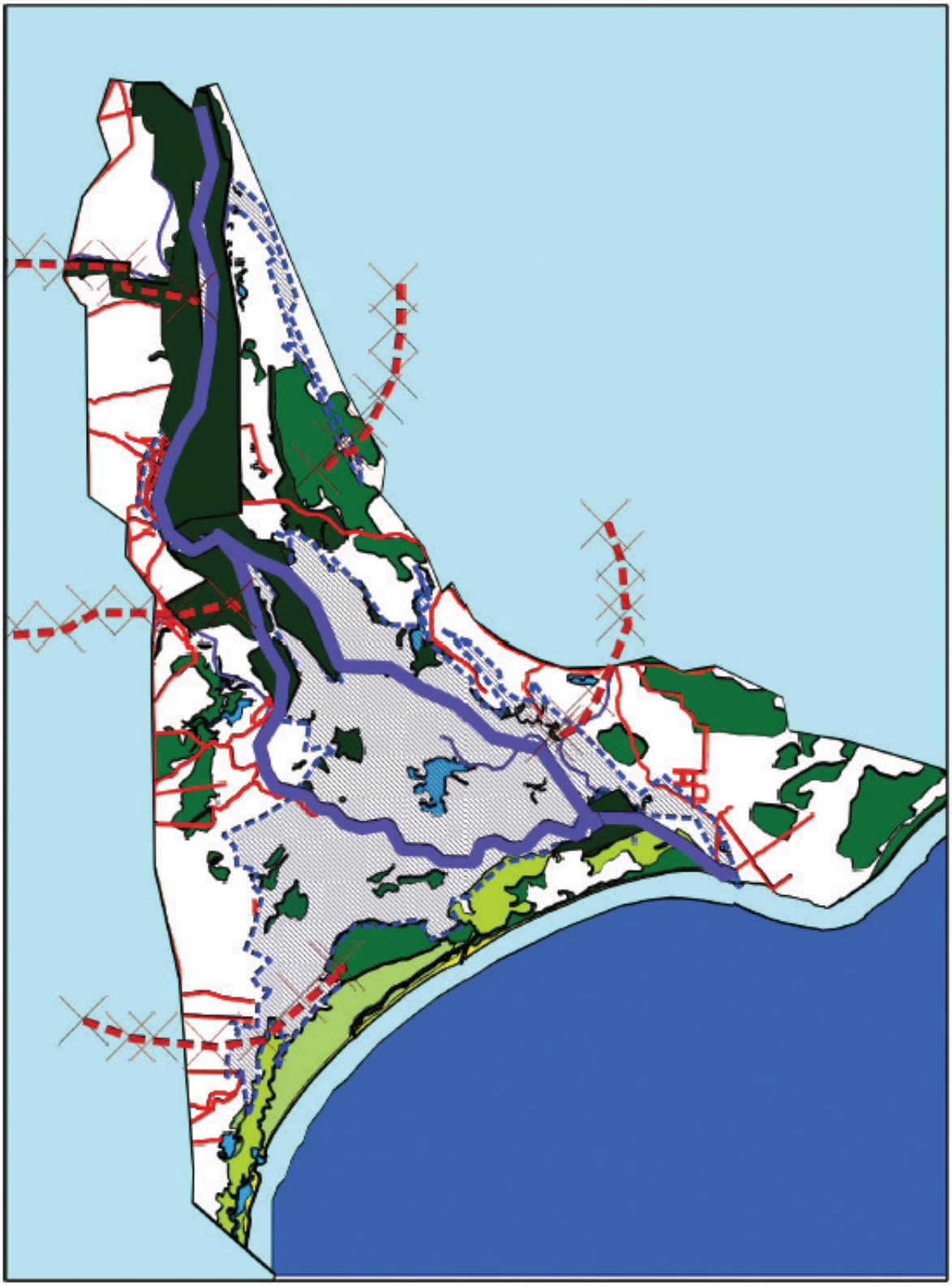
Tana Delta provides vital ecosystem services to a much wider area than the delta itself, due to its retention of water and wetlands in the dry seasons and the availability of grazing for both wild and domesticated animals.

Large herbivores have used fixed migratory routes between areas like Tsavo East National Park and other areas of North East Kenya for centuries. The migrations take place twice a year and although they are on a much smaller scale than the internationally famous Serengeti/Masai-Mara migration, they are nevertheless of great importance in preserving elephant and antelope populations across the entire region. Five routes exist into the delta; two from the north east and three from the north west and west and their positions are shown in Figure 2.10. The same routes are used by pastoralists when herding cattle between the delta and wet season grazing areas (Hamerlynck, 2010).

In addition to the established migratory routes, land lying between separated blocks of riverine forest and other habitats within the Delta serves a similar function in allowing mobile species, like primates and birds, to

travel to and from different territories. Conversion of these areas from thicket, scrub or grassland to permanent agriculture increases the isolation of remote habitats and increases the pressure on the survival of rare species.

Figure 2.10 Wildlife and Livestock Migration Routes



2.12.5 Birds

Birds constitute a very important part of the Delta ecosystem and apart from justifying its status as an Important Bird Area (IBA) they are also a significant dimension in the area's designation as a Ramsar site. At least 345 species of birds have been recorded at the site (Bennun and Njoroge, 1999). These include 5 globally threatened and 4 regionally threatened bird species (Table 2.7). More than 22 species of wetland birds gather in the Delta in numbers which are of international significance, and there are a number of large colonies of water birds such as egrets, herons and ibis (Bennun and Njoroge, 1999).

Brief surveys in 2008 and 2010 continued to record large numbers of congregatory waterbirds; four globally endangered bird species, two listed as vulnerable and seven near-threatened.

Table 2.7 Rare and Endangered Birds Found in Tana River Delta

Water birds found in globally important numbers in the Tana Delta in 1992-3 (more than 1% of biogeographic populations):	
Great White Pelican	Grey Heron
Pink-backed Pelican	Purple Heron
Cattle Egret	African Open-billed Stork
Yellow-billed Egret	Sacred Ibis
Great Egret	Glossy Ibis
African Open-billed Stork	African Spoonbill
African Spoonbill	
Greater Flamingo	**Globally-threatened Birds in Delta:**
Spur-winged Goose	*(Tana Delta report, June 2008, by Fleur Ng'weno – Nature Kenya)*
White-fronted Plover	Hooded Vulture (endangered)
Lesser Sandplover	White-backed Vulture (endangered)
Little Stint	Rüppell's Vulture (endangered)
Curlew Sandpiper	Basra Reed Warbler (endangered)
Marsh Sandpiper	Lappet-faced Vulture (vulnerable)
Sooty Gull	Madagascar Pratincole (vulnerable)
Slender-billed Gull	Bateleur (near threatened)
Gull-billed Tern	Southern Banded Snake Eagle (near threatened)
Caspian Tern	Pallid Harrier (near threatened)
Lesser Crested Tern	Martial Eagle (near threatened)
Saunders' Tern	African Skimmer (near threatened
Water birds known to nest in Tana Delta:	Eurasian Roller (near threatened)
(*Oliver Nasirwa, unpublished report, 1993*):	Malindi Pipit (near threatened)
African Darter	Tana River Cisticola (data deficient)
Black-crowned Night Heron	
Black Heron	**Regionally-threatened birds:**
Squacco Heron	African Darter
Little Egret	Great Egret
Yellow-billed Egret	Saddle-billed Stork
Great Egret	Scaly Babbler

Source: Tana Delta Survey by Oliver Nasirwa, 1992-3, unpublished, and Tana Delta report, June 2008, by Fleur Ng'weno – Nature Kenya

2.12.6 Other Wildlife in the Tana River Delta

Other wildlife of conservation concern in the area include the threatened, range-restricted East African coast subspecies of the Topi on land, and the marine species Dugong dugong (globally categorised as vulnerable but regionally as critically endangered) and turtles nesting on the sandy beaches. The rivers and channels support large numbers of hippo and crocodile. Twenty-two freshwater fish species are recorded from the lower Tana, including three eels. The mangroves provide vitally important spawning and nursery grounds for many species of fish and crustaceans. The extensive mangrove forests include the only significant stands in Kenya of the plant Heriteria littoralis (Bennun and Njoroge, 1999).

There are 320 plant taxa in the Lower Tana River; 58 of them tree species, of which two are considered Critically Endangered in a global sense. Twenty one per cent of the plants are of conservation concern, and the area hosts seven plants on the IUCN Red list of threatened species. The discovery of several trees of Cassipourea gummiflua in 2005 was only the second time this species has been recorded in coastal Kenya and possibly only the third time in Kenya (Luke *et al*, 2005).

Three shark species listed under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) Appendix 1 have been recorded in the Tana Delta. The sharks enter estuaries occasionally, and their populations are greatly impacted by habitat degradation (Nyingi *et al*, 2007). A further two fish species in the Delta are Red-listed as data deficient. Three important amphibians include the endemic Tana River caecilian, Boulengerula denhardti and the near-endemic mud-dwelling caecilian Schistometopum gregorii. Reptiles in the Delta include the near-endemic Tana writhing skink Lygosoma tanae and the Ngatana or mabuya-like writhing skink Lygosoma mabuiiformis (Malonza *et al*, 2006).

2.12.7 Tana River Forests

Tana River Forests are composed of riparian forest patches maintained by underground water from River Tana in a broad floodplain, 1–6 km wide, that is covered by alluvial sediment deposited during floods (Bennun and Njoroge, 1999). There are about 71 distinct forests, ranging in size from 1–1,100 ha and covering c.3, 700 ha in total. The forests lie on both banks of River Tana. Of the 71 patches, 16 (covering 1,000 ha) fall within the 17,100 ha Tana River Primate National Reserve (Bennun and Njoroge, 1999).

Tana River Forest patches have been recognized as an Important Bird Area. At least 200 bird species have been recorded in the forest patches and surrounding areas. Notable bird species in the forest patches include the endangered Basra Reed Warbler and 5 near threatened species including Southern Banded Snake-eagle, Fischer's Turaco, East Coast Akalat, Plain-backed Sunbird and Malindi Pipit (Bennun and Njoroge, 1999).

Tana River Forests provide the only remaining habitat for two endangered primates, the Tana River Red Colobus and the Tana River Crested Mangabey. The populations of these species have decreased considerably in recent years and both are among the 25 most endangered primates in the world (Butynski and Mwangi, 1995 - cited in Bennun & Njoroge, 1999). Tana River Forests have a high diversity of amphibians and fish. The Lower Tana riverine forests are unique in Kenya, being remnants of continental forests resembling western African vegetation communities. Up to 175 woody plant species belonging to 48 families have been recorded in 12 forests patches within Tana River National Primate Reserve (TRNPR) (Medley, 1993 – cited in Bennun & Njoroge. 1999). Due to long geographic isolation of this forest community from the rain forests of central Africa (Medley 1992) there are high levels of endemic plant and animal species within the forest patches. At least 61 plants found in the forests are globally or nationally rare and notable species (Bennun and Njoroge, 1999).

2.12.8 Prime Habitats

The status and condition of the natural environment in the Delta is heavily dependent upon the protection and enhancement of the many varied habitats which give rise to its biological diversity. In one sense the special qualities of the Delta stem from the richness of all the habitats. Consequently the loss or deterioration of any component will inevitably weaken the whole. However, some areas may be regarded as of exceptional importance because together they sustain the most important fauna and flora of the Delta. These areas, regarded as primary habitats, are shown in Table 2.8.

Table 2.8 Primary Habitats Making up the Core of the Tana Delta

Habitat Type	Area in Km^2
Forest	271
Riverine Forest	323
Water	18
Floodplain grassland	508
Mangrove	84
Dunes	103
Migratory Corridors through thicket	100
Total	**1036 = 100**

The term "primary habitat" is used to distinguish between the core areas and other 'secondary' habitats that are important for individual species but are not the primary reason for the area's designation as a Ramsar site. In addition to the specific habitats listed in table 2.8, another critical component of the Delta' biodiversity is the existence of migratory land corridors through the buffer zone which are used by both wild animals and livestock in order to pass between the core of the Delta and the wider rangelands - see Figure 2.10. It has been assumed in this assessment that each of the existing five corridors should be maintained with a minimum width of two kilometres and a length of 10 kilometres through those parts of the thicket and scrub zone lying within the Plan Area.

The current main conservation challenges for the Lower Tana Delta are:

- Competing land uses
- Lamu Port-South Sudan-Ethiopia Transport (LAPSSET) corridor
- Human-wildlife conflicts
- Encroachment of human settlements
- Environmental degradation e.g. destruction of woodland and mangroves, selective logging, slash-and-burn agriculture
- Habitat fragmentation: due to forest degradation as a result of various activities.

2.12.9 Ecosystem Services

Ecosystem services are the benefits people obtain from ecosystems. These include:

- **Provision** – the goods or products obtained from ecosystems, such as food, water, timber and fibre
- **Regulation** – the benefits obtained from the regulation of ecosystem processes, such as climate, flood, disease, waste and water quality
- **Culture** – the nonmaterial benefits people obtain from the regulation of ecosystem processes, such as recreational, aesthetic and spiritual benefits
- **Support** – the supporting processes such as photosynthesis and nutrient cycling that are necessary for production of all other benefits.

Tana River Delta is providing a wide range of ecosystem services. Hamerlycnck *et al* (2010) have made an initial classification of these – see the table 2.9.

2.13 Summary of Baseline Characteristics in the Tana Delta

Table 2.10 provides a summary of the baseline characteristics in the Tana Delta which is used for comparative purposes in later sections of the SEA and the evaluation of scenarios for future development.

Table 2.9 Ecosystem Services in the Lower Tana

Provisioning services	
Food	Recession agriculture, small-scale flood irrigation, mobile livestock keeping, capture fisheries, collection of wild plant and animal food products
Fiber	Timber for canoes and construction, beehives, roof thatch and weaving products from palms, wood fuel
Clay	Construction of mud houses, brick-baking, pottery, fertilization of soils
Genetic resources	Not studied, potentially some traditional crop varieties
Biochemicals, natural medicines and pharmaceuticals	Important role of forests for local medicinal products, honey and palm wine
Freshwater	Surface water for various uses and groundwater recharge (subsurface waters are in general saline)
Regulating services	
Air quality regulation	Dynamic forests in different life stages with efficient carbon fixation, barrier to wind erosion
Climate regulation	Evapotranspiration by forests, oxbow lakes, etc.
Water regulation	Reduction of flood peak between Garissa and Garsen (see figure 4)
Erosion regulation	Riverine forest slows bank erosion and stabilises meanders
Water purification and waste treatment	Absorption of nitrogen, reduction of sediment loads by deposition in the floodplains
Disease regulation	Not studied
Pest regulation	Not studied
Pollination	Not studied but most probably important
Natural hazard regulation	Resilient ecosystems continue to provide services during climate extremes
Cultural services	
Cultural diversity	Different livelihood strategies complement each other e.g. fertilisation of fields by livestock, provision of wild foods and milk in exchange for farming produce
Spritual and religious values	Not as strong as in the Mijikenda of the more southern coastal forests but there is a strong emotional affinity with the traditional landscapes
Knowledge systems	Elaborate traditional knowledge under threat (sedentary lifestyle, schools, wage jobs, outmigration to towns)
Educational values	Teaching of bush practice and traditional pharmacopeia
Inspiration	Many locals enjoy transect walks and being in the bush
Aesthetic value	Both traditional and modern
Social relations	Rituals by elders of various communities for access to resources
Sense of place	People who received land at Kipini in compensation have remained attached to their ancestral lands, return of livestock keepers to abandoned TDIP land (Wardei)
Cultural heritage values	The Pokomo claim they brought the Red Colobus with them from Central Africa
Recreation and ecotourism	Good potential but issues with the security situation, access, infrastructure and human capacity (language, training of local guides)
Supporting services: soil formation, photosynthesis, primary production, nutrient cycling and water cycling underlie all the other services and are usually not included to avoid double counting in ecosystem valuation	

Source: Hamerlynck *et al*, 2010

Table 2.10 Baseline Summary

Component	Measure/Unit	2010
Population	Thousands	102
Workforce	Thousands (51% of population LUP Baseline Report)	52
Urban Area	Km^2	26.2
Industrial land	Hectares	10
Open Grazing	Area occupied (Km^2)	1,128
	Livestock - Maximum number	735,000
	Livestock - Minimum number	220,000
	Livestock - Average number	477,500
	Average value (KSh Billion @ 12,000/head)	5.73
Ranches	Area occupied (ha)	9,200
	Livestock - Maximum number	480
	Livestock - Minimum number	0
	Livestock - Average number	480
	Average value (KSh million)	3.1
Farming	Potential Arable Area (Km^2)	1,100
	Permanent Cultivation (Area Km^2)	6.2
	Subsistence (Number of people supported)	102,000
	Value of crop production (KSh million)	62
	Irrigated land (ha)	385
	Labourers ('000s)	12
	Commercial farms (Has)	450
Fishing	Number of Kgs/annum	613,003
	Value (KSh million)	53,136,500
Bee keeping	Number of hives	12,150
	Honey (000 Kg)	68-96
	Value (KSh million)	20-29
Natural Products	Area required for harvesting (Km^2)	55-85
	People engaged in NTFP harvesting	4971
	Income generated (KSh million)	80
	House building using natural materials (KSh million)	100
	Employment in house construction (number of jobs)	1165
	Charcoal / Firewood (000 tonnes)	153-236
Tourism	Turnover (Value '000 USD)	26
Industry & Mining	Area Involved	0
	Turnover (Value USD)	0
Water Demand	Domestic (m^3/day)	2040
	Commercial / Industrial (m^3/day)	0
	Livestock (m^3/day)	4,748
	Farming (m^3/day)	10,548
	Environmental Reserve (m^3/day)	5.2 million
Biodiversity	1,026 Km^2 Prime habitats = 100	100

Source: Tana Delta Land Use Plan, 2014

PART FIVE: KEY ISSUES IN THE TANA RIVER DELTA

2.14 Introduction

The Tana Delta is faced with many challenges and it is the role of the SEA first to identify the issues that need to be resolved and then to provide recommendations for a comprehensive planning strategy that will help to avoid problems and maximise opportunities for sustainable development. The issues identified in the SEA Scoping Report included the topics listed as priorities in Figure 2.11. The following text discusses the main findings and Table 2.11 summarises the key issues and possible solutions.

2.14.1 Influx of Investors

For more than half a century, the Tana Delta and Lower Tana River Basin have been perceived as tracts of land with low levels of population, extensive patches of fertile soils suitable for cultivation and an abundance of water. These resources have been promoted for development by successive national governments, beginning during the colonial administration, and assisted over the decades by international aid agencies.

Unfortunately the failure of successive schemes, which have been well documented, and the changing circumstances in terms of population, land use and water resources have not been factored into subsequent development plans, leading to increased social tensions within the Delta and a declining economic base.

Contrary to the established view, the Tana Delta has a large and rapidly growing population of over 100,000 people who are entirely dependent on its natural resources and the ecosystem services which these resources provide for their livelihoods. Its soils are not homogeneous but are in fact highly variable in quality, reflecting the constantly changing environment of the Delta where river channels can move in a matter of weeks and fertility is governed by the annual spreading of silt washed down from the highlands, hundreds of kilometres away. The third illusion is the assumption that the Delta has a surplus of water which can be diverted for other uses apart from sustaining local people and the ecosystem on which they depend. In practice, water supplies to the Delta have been declining since the five major dams in the upper Tana catchment were constructed in the period between 1960 and 1990. In addition to the critical role which floods play in modifying river channels, spreading silt and sustaining key habitats, the more or less constant base flow in the River Tana throughout the remainder of the year helps to recharge ground water and sustain soil moisture content in the core wetlands.

External investors and previous governments have attempted to generate wealth from the Delta through poorly conceived, constructed and maintained schemes, including the Bedford biofuels project, a former G4 Industries farming project, and proposals like the allocation of land to the Qatar Government to grow food for export, while local initiatives to establish irrigation schemes for rice production have also been hit by numerous constraints.

The SEA has shown that many of these failures could have been foreseen if fully objective EIAs and technical studies had been performed in advance, and if the political and institutional structures had been sufficiently robust to ensure that the national interest overrode private interests and individual gain.

2.14.2 Changes in Hydrology and Water Use

The most recent technical feasibility studies for the High Grand Fall Dam in the Upper Tana Basin have confirmed that the concept of establishing a large irrigation project in the Tana Delta is outdated and that any future irrigation schemes should be developed in locations that are not affected by the twice yearly flood events. Although dams in the upper catchment have attenuated flood flows, and the HGFD will greatly add to regulation of natural flows throughout the year, major flood events continue to occur on a cyclical timescale of 5-7 years. These floods are so large that they will continue to dwarf the impounding effect of man-made barriers, and will overwhelm any dykes unless these are constructed on such a scale that they destroy the Delta themselves.

The SEA has demonstrated conclusively that, contrary to the established view that flood events originating in the Upper and Middle catchment have little or no effect on the Delta, the lower River Tana responds in the same way to rainfall events in the highlands as the upper river. It is also affected by flash flooding from major lagas, which bring very large but unquantified volumes of flood water into the Delta.

The normal flow conditions in the River Tana as it enters the lower Delta at Garsen (Idsowe Bridge) are above 60m^3/second and this volume of water is critical to the survival of the Tana Ecosystem and local livelihoods.

Plans for the development of water resources in Kenya inevitably affect the River Tana since it carries 70% of the country's surface flow. These proposals include power generation, the development of large irrigation schemes, provision of water to Nairobi and the LAPSSET corridor including the new Port of Lamu.

Table 2.11 Summary of Key Issues in the Tana River Delta

Issue	Description
Influx of large scale investors to the delta	• Identify all large scale investments in the delta and assess their social, cultural, economic and environmental implications. • Consider the nature of existing decision-making processes
Changes in hydrology and Water use	• Examine annual and seasonal river flows, the effects of droughts and flooding and changes in river morphology • Evaluate e water availability, accessibility and demand in the basin and within the delta.
Resource use conflicts	• Establish the nature of conflicts within the delta including:. - Competition for land and resources between communities living in the delta (pastoralists farmers and fishing communities) - Competition for grazing land and water between pastoralists living in the delta and those coming from outside (Lamu, Garissa and Wajir county) - Competition for forest resources - Competition between large scale commercial agriculture and communal farming and fishing activities - Competition for water between fishing communities and other resource users - Potential development of mineral resources (oil and gas)
Increasing human/wild life conflicts	• Evaluate the status of traditional wildlife migratory corridors (especially for large mammals e.g. elephant) • establish wildlife migration patterns to inform the Land Use Plan
Unfair decision-making processes	• Examine decision-making processes relating to land use allocations, resource use and investments.
Evolving upstream activities	• Investigate changes in the upper catchment of Tana river arising from increased population, infrastructure development and new economic activities. (agriculture/ irrigation / multi-purpose dam construction)
Population dynamics	• Examine the nature of population change including: - Overall growth rates - Inward and outward migration - Age and gender structure
Climate change and variability	• Assess climate change and variability as an externality in the management of the delta including its potential effects on: - livelihoods - future land use. - vegetation and biodiversity
Proposed developments on the Coast	• Examine the implications relating to large scale development including: - Construction of the Lamu Port and LAPPSET corridor, prospecting and mining activities • Define the nature, magnitudes and intensity of these developments and their likely impacts on the sustainability of the delta
Socio-cultural influences	• Investigate cultural/religious traditions Including community attitudes and perceptions to conservation efforts which are perceived as not addressing their immediate economic benefits. • Explore the contribution of indigenous technical knowledge • Evaluate the role played by communities in decision-making processes • Explore constraints arising from inadequate skills and low literacy levels and their consequences in the modern knowledge-driven economy.

Source: Tana Delta Land Use Plan, 2014

These projects are described as flagship initiatives in Vision 2030 and the government is committed to their development but if all the national goals and objectives set out in this Vision and the Constitution are to be met it is essential that the schemes are designed in such a way that the natural resources, livelihoods and people of the Tana Delta are protected.

2.14.3 Resource Use Conflicts

Political and social conditions in the Tana Delta have been volatile for some decades, reflecting the very different lifestyles, culture and livelihood requirements of the two main groups of inhabitants which are based on sedentary farming and migratory livestock rearing. A combination of circumstances, including population growth, increase in the size of livestock herds, reduced water flows, the onset of climate change and new administrative structures have all played a part in creating the conditions within which armed conflict can flare up. The evidence from the SEA is that the underlying competition for scarce natural resources is certain to increase in the short-term and only the introduction of agreed standards for land use planning can help to minimise disputes.

2.14.4 Increased Human-Wildlife Conflicts

For centuries, elephant, buffalo and other large mammals have followed migratory routes from locations like Tsavo East and the northern rangelands to the core of the Delta to find water in the dry season and to breed. As the human population has grown the width of migratory corridors has been reduced, with individual settlements actually being built within the corridors. In addition, land has been cordoned by dykes and fences to allow for irrigation of crops like maize and rice, which attract herbivores in large numbers. With proper management wildlife can be accommodated alongside farming and ranching, but it requires detailed knowledge of animal behaviour and strong political commitment to develop and implement the necessary measures.

Table 2.12 Summary of Key Issues and Possible Solutions

Key Issue	Description	Possible Solutions
POPULATION/ SETTLEMENTS - Rapid population growth and increased settlements.	There is encroachment and degradation of wetlands and other protected areas. Biodiversity and natural resources are threatened including from charcoal burning. The nature of settlements in the Delta has also been a hindrance to provision of infrastructure.	A human settlement strategy for the Delta should provide an elaborate settlement pattern for the communities to ease provision of infrastructure.
LAND - Land ownership	The land question in the Delta remains a challenge. The majority of local communities have no land ownership documents. Large tracts of land are owned by relatively few individuals while the majority occupy land which they claim is ancestral although it remains un-adjudicated. Due to the tenure insecurity, squatters rarely practice farming and have resulted to charcoal burning as a means of earning their livelihood. This has resulted in a massive reduction in vegetative cover due to felling of trees.	There is a need to adjudicate land and review land leases granted to the foreign companies in order to secure tenure for the local communities and resettlement of squatters.
ECONOMIC BASE - Food insecurity	Food insecurity in the Delta is at an alarmingly high level, with dependence on relief food –especially during the drought spells – a common phenomenon. High poverty rates and climate change have been perceived as the underlying causes of food insecurity.	Propose strategies on sustainable agriculture and diversification of livelihoods to ensure food security.
ECONOMIC BASE - Poverty	Poverty levels in the Delta are extremely high. About 95% of the population in the Delta reside in the rural areas and depend on subsistence farming for survival with barely any surplus produce for the market. Poverty has also forced the communities in the Delta to venture into wetlands and forests in search of alternative sources of livelihoods e.g. charcoal burning.	Propose strategies that will allow for diversification of livelihoods to avoid the dependence on rain fed agriculture and pastoralism as the only source of livelihoods for the communities in the Delta.
ECONOMIC BASE - Unexploited potential	Unexploited potentials in the Delta include tourism, marine resources, improved agricultural production, close proximity to the proposed LAPSSET project and fisheries.	Propose planning strategies to suggest the most viable ways to exploit the untapped potentials in the Delta. Use formal training to equip the youth with the necessary skills.

Key Issue	Description	Possible Solutions
INFRASTRUCTURE & SERVICES - Lack of enabling infrastructure and services	Infrastructure is key in the development of any area. The planning area is under-developed in terms of infrastructure. The road network is poor, lack of organized markets and market amenities have hindered trading, adversely affecting sectors such as agriculture. Basic services such as water and sewer reticulation are also lacking. Other social amenities such as recreation and leisure are also not available.	An analysis of the population as well as projections need to be done and the infrastructure demand established.
DEVELOPMENT TRENDS - Agriculture expansion and intensification	Agricultural expansion in the Delta (e.g. the contemplated large-scale projects) is likely to exert pressure on the land and resources in the Delta due to vegetation clearance, pollution and increase in water demand. This will impact ecosystem services and biodiversity. Pressure on existing infrastructure will also increase.	A comprehensive strategy that rationalizes natural resources management should be put in place in the implementation of the agricultural extension projects to avert the likely outcome of environmental degradation and biodiversity loss.
DEVELOPMENT TRENDS - Impacts of proposed developments on the River Tana and Tana Delta, particularly LAPSSET, Tana Delta Irrigation Project and the High Grand Falls Dam.	The LAPSSET project will draw water for domestic and industrial use from River Tana; construction of Lamu port will stimulate major economic development opportunities resulting in a massive increase in population which will exert further pressure on the resources in the delta. The construction of High Grand Falls Dam upstream for power generation, irrigation, water supply and flood control will also greatly impact on the Delta ecosystems and community livelihoods.	More transparent planning processes for these major projects informed by SEA.
GOVERNANCE - Weak legal and institutional frameworks and multiple and competing policies, institutions and legislations.	The result is an uncoordinated approach to managing resources in the Delta. This is further marred by the overlapping and conflicting mandates of the various institutions.	Review and make recommendations for improving legal and policy coherence and institutional mandates.

Key Issue	Description	Possible Solutions
CONFLICTS - Resource use conflicts	Resource use conflicts have intensified in the Delta as a result of increased pressure on the natural resources due to rapid population increase, climate change, land use conversions, insecurity of land tenure, etc. The conflicts manifest themselves in the form of wildlife – human and human – human conflicts.	Management of human conflicts through designating grazing and farming zones as well as rationalizing livestock numbers against available pasture. Management of human-wildlife conflicts by mapping the wildlife conservation areas and controlling movement into the areas.
CLIMATE CHANGE	Preliminary research on the potential impact of climate change indicates increased evapo-transpiration and potentially higher rainfall in the basin. This would accentuate the effects of floods and droughts.	Further research is needed to assess the likely significance of climate change within the River Tana Basin.
WATER - Hydrology	Understanding of the hydrology of the Lower Tana Basin is poor.	Ideally plan and implement detailed hydrological studies.
WATER - Future Water Demand	Some of the key developments will generate major demands for water over the next thirty years. It is clear that the combined demands of irrigation linked to the High Grand Falls Dam and water supply for the LAPSSET projects already exceed the available water supply in the River Tana.	Ideally collect further data on other pressing demands for water from the River Tana, including the growth plans for Nairobi and the Rift Valley and study growth patterns to determine what conditions would have to be met to ensure that a sustainable balance can be achieved between water supply and demand.
WATER - Safeguarding the Environmental Reserve	Tana Delta has been designated as a Ramsar site (wetland of international importance) and its sustainable management must be secured. An initial calculation has been made of the environmental reserve needed to protect downstream livelihoods and the ecology of the Delta.	Ideally new studies to confirm the proposed value for the environmental reserve flows in the Lower Tana River.
WATER - Levels of assurance on flood discharges	Upstream developments e.g. the Grand High Falls dam includes proposals to introduce water resource management rules, including provision for the release of artificial floods.	Investigate proposals in depth and formalize discharge requirements through appropriate legal procedures.

Key Issue	Description	Possible Solutions
WATER - Effects of water transfers and off-channel water diversions	Plans to transfer water out of the channel e.g. to Lamu or within the channel e.g. for irrigation will affect the river levels in the Lower Tana.	All plans for transferring water outside the River Tana Catchment need to be subject to full environmental assessment. Given the cumulative nature of the proposals this assessment should be undertaken as an SEA or Cumulative Environmental Impact Assessment.
BIODIVERSITY	While it is without doubt that the whole of the Tana catchment is important for biodiversity including the Primate Reserve, Tana River Forests and Tana Delta, there is a lack of detailed information about the precise locations of many of the habitats and species and detailed population information about species. In addition, detailed information about the vital ecosystem services the Delta is providing.	Map and safeguard key biodiversity hotspots within the planning area.

CHAPTER 3 National And Regional Development Scenarios

Introduction

The Tana River Delta is located in a part of Kenya that will undergo very significant changes in the next 50 years. These include variations in temperature, rainfall, river flow and biodiversity as a result of global warming but also major changes in the region's economic and social conditions arising from Government policy and individual and corporate initiatives.

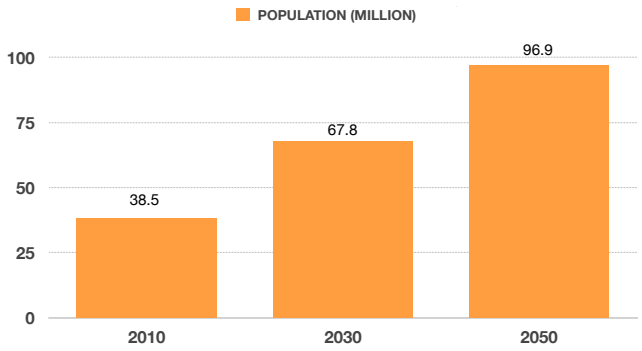
In considering developments over the next 17 years it is possible to build up a picture of change based on specific proposals contained in Vision 2030 and other strategic documents like the National Water Management Plan, 2030. However, the situation beyond 2030 is likely to be much more fluid. This Strategic Environmental Assessment which accompanies the Tana Delta Land Use Plan has examined the likely pattern of change up to 2030 in Part One and subsequent changes to 2050 in Part Two.

PART ONE: NATIONAL SCENARIO 1 - CHANGES TO 2013-2030

3.1 Population

Kenya's population is one of the fastest growing in the world with an average increase of 2.7% (which is exceeded in the Tana Delta due to both the natural birth rate and inward migration). Figure 3.1 shows the anticipated population growth for the country as a whole to 2030.

Figure 3.1 Anticipated Population Growth in Kenya



Source: Tana Delta Land Use Plan, 2014

In the country as a whole, most of the population increase is forecast to occur in the urban areas as people move to cities and towns in search of work, better services and infrastructure. Nevertheless, certain rural areas will continue to attract migrants and if the current growth rate in Tana River County continues unabated over the next 17 years, the number of people living in the wider Tana Delta area will have risen from 200,000 to over 340,000, while the number of residents in the Delta will have risen from 102,000 to 175,000.

3.2 Livelihoods

According to the Tana Delta Land Use Plan (Odhengo *et al*, 2014b) without any changes in current conditions in the Tana Delta, the rising population, from both the excess of natural births over deaths and inward migration, will reach in excess of 175,000 people in 2030, almost two thirds higher than at present. Assuming that this population increase is evenly split between farming and pastoral communities, the 30,000 additional people needing to be fed by farmers would require in the region of 2,500-5,000[5] hectares of farmland by 2030. The same number of people would be dependent on meat and dairy products from livestock rearing, requiring in the region of 50,000 animals[6]. The grazing area needed to sustain this number of animals would represent 70,000 hectares[7] of dry grassland, or around 20,000 ha of wet grassland in the flood plain which is 30% of the entire area of the core floodplains in the delta, and does not take into account the existing high levels of overgrazing in the dry seasons (Odhengo *et al*, 2014b).

3.3 Social Welfare

Existing economic programmes under Vision 2030 are focused on the development of flagship projects. This model assumes that the increased economic wealth of the nation will then be able to cross subsidise and fund welfare programmes to help the needy in all areas. Given the current emphasis on using parts of the Tana River basin as the 'bread basket' for the country, through development of commercial irrigation, there is

[5]Assuming an average family size of 6 and 0.5-1 hectare per family.
[6]Assuming 10 cattle per household allowing a range from 2-100.
[7]One tropical livestock unit per 7 hectares – dry arid grasslands.

a potential conflict of interest in also seeking to upgrade the lives and livelihoods of the rapidly expanding rural population in this region as noted in section 3.3 above.

3.4 Economic Activity

Many of the most significant flagship projects of Vision 2030 are planned in North Eastern Kenya, within the Tana River Basin and land extending to the borders with Ethiopia and Somalia. These include the LAPSSET programme and large scale irrigation.

3.4.1 Lamu Port / Lamu-South Sudan-Ethiopia Transport Corridor Project (LAPSSET)

LAPSSET is a transport and infrastructure project that, when complete, will be Kenya's second strategic transport corridor (Government of Kenya, 2012). Kenya's existing transport corridor is the Mombasa port and Mombasa – Uganda route that passes through Nairobi and much of the Northern Rift. The LAPSSET corridor will involve the following components:

- A port at Manda Bay
- Standard gauge railway line to Juba (capital of South Sudan)
- Upgraded Road network
- Oil pipelines (Southern Sudan and Ethiopia)
- Oil refinery at Bargoni
- Three Airports
- Three resort cities (Lamu, Isiolo and Lake Turkana shores) (Government of Kenya, 2012)

The project was initially conceived in the 1970's but upgrading of the existing Mombasa Port and transport corridor took priority. The project was later revived and included in Kenya's Vision 2030. LAPSSET's cost was estimated to cost $16 billion in 2009 (Government of Kenya, 2012). More recent estimates indicate costs of the project at US$22-23 billion http://en.wikipedia.org/wiki/Lamu_Port_and_Lamu-Southern_Sudan-Ethiopia_Transport_Corridor - cite_note-3 (Government of Kenya, 2012). On 1 April 2013, Kenya's government announced the setting up of a government agency, the Lamu Port Southern Sudan Transport Development Authority that will manage the project on behalf of the Kenyan government. The cost of the project was put at KSh. 2.5 trillion ($29.24 billion).

Work has commenced on different stages of the project in a somewhat random manner. Some elements, like the Isiolo-Merille projects, began in 2007. At the peak of the project, between 2013 and 2018, it is expected that the Kenyan government will be spending about 6% of the country's Gross Domestic Product or 16% of its annual budget on the project. The project is in turn expected to contribute an additional 3% increase in Kenya's GDP by 2020.

The aim of the project is to cut over-dependence on Kenya's main port of Mombasa as well as open up Kenya's largely under-developed northern frontier, through creation of a second transport corridor.In practice, the developments triggered by the LAPSSET programme will continue to evolve in future decades, extending well beyond 2050.

3.4.2 Irrigation

The second major economic development in the Tana Basin is based on extending the area of land under irrigation. The three main flagship programmes are the reinstatement of the Hola and Bura Irrigation Schemes, together with the excavation of a 50 kilometre canal. These initiatives are dependent on providing new reservoir storage capacity in the Upper Tana Basin. The third and biggest plan is the Galana/Kulalu Ranch irrigation scheme. In this project the Kenyan Government proposes to irrigate 1 million acres in Galana/Kulalu Ranch for food security (Office of the Presidency, 2014).

3.5 Water Demand

River Tana contains 70% of the available river water in Kenya (Government of Kenya, 2012) and will experience rapid development to meet the growing needs of Nairobi, the LAPSSET corridor and Vision 2030 forecasts for irrigation development in the Tana River Basin. Currently Nairobi has a daily demand of 750,000 cubic metres but can only rely on 500,000 cubic metres. This demand is forecast to rise to 2.5million cu m/d in 2030 (Government of Kenya, 2012).

The new town of Lamu Industrial Port is projected to have a population of over 1 million by 2030, creating demands for a further 96,000-160,000 m^3/day (JPC & BAC/GKA JV, 2011). This supply is required for domestic consumption, but other elements of the Lamu development including the port, industry etc. will raise the total requirement to between 185,000 – 250,000 m^3/day **(Table 3.1).**

If the forecast development of irrigation potential in the Tana River Basin is realised in accordance with Vision 2030, up to 3,635 million cubic metres of water a year would be required for this use alone by 2030.

Table 3.2 shows the cumulative demand from these specific uses and makes no allowance for other uses including abstraction of water for farming in the Upper Catchment.

Table 3.1 Water Demand Forecasts for the Lamu Port and LAPSSET Project

Year	Population Ranges		Domestic Demand (m^3/day)		Port Demand & Refinery	Indust. & Other Amen. (m^3/day)		Total Demand (m^3/day)	
	Minimum (E)	Maximum (L)	(Min) DD1	(Max) DD2		Industr. Demand	30% Other Amenities	(Min) DD1	(Max) DD2
2010	25,000	25,000	2,000	2,000	350		510	2,860	2,860
2015	65,000	125,000	5,200	10,000	2,100	1,560	3,000	11,860	16,660
2020	100,000	287,500	8,000	23,000	2,850	2,400	6,900	20,150	35,150
2025	150,000	437,500	12,000	35,000	2,850	3,600	10,500	28,950	51,950
2030	250,000	600,000	20,000	48,000	7,250	16,675	14,400	58,325	86,325
2035	400,000	750,000	32,000	60,000	7,250	16,675	18,000	73,925	101,925
2040	675,000	900,000	54,000	72,000	7,250	30,210	21,600	113,060	131,060
	Minimum (L)	Maximum (E)							
2045	1,050,000	1,100,000	84,000	88,000	8,700	33,230	26,400	152,330	156,330
2050	1,200,000	2,000,000	96,000	160,000	8,700	33,230	48,000	185,930	249,930

NB: DD1=domestic demand based on minimum population projections; DD2=domestic demand based on maximum population projections.
Source: Inception Report – Provisional Statistics (JPC &BAC JV)

Source: JPC & BAC/GKA JV, 2011

Table 3.2 Cumulative Water Demand by 2030 in the Tana River Basin

Location / Use	Million m^3/day	Billion m^3/year
Nairobi	2.0	0.730
Lamu / LAPSSET	0.2	0.073
Irrigation	9.95	3.635
Total Water Demand	12.15	4.438

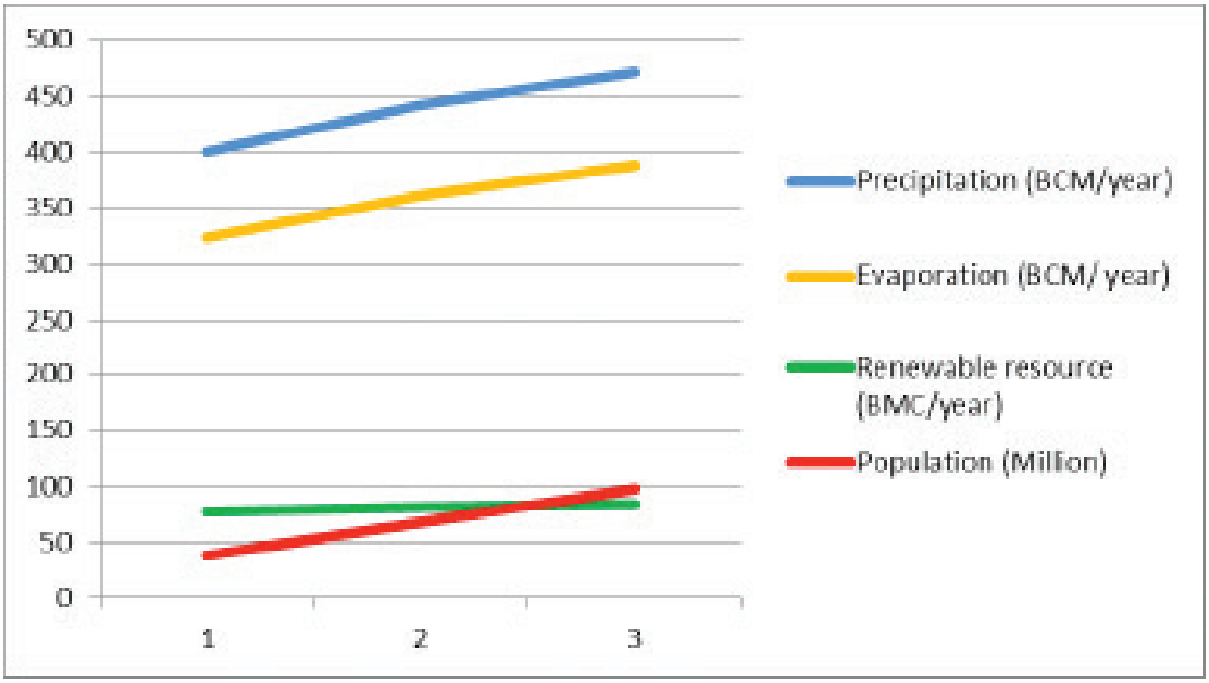
3.5.1 Water Supply

The current storage capacity in the 5 dams already in operation in the Upper Tana Basin, including Masinga Dam which holds 1.65 billion m^3, amounts to around 2.2 bcm (Odhengo *et al*, 2012c). This will be greatly enlarged by the construction of the High Grand Falls Dam (GHFD) which will have a storage capacity in excess of 5.6 billion m^3. The feasibility study for HGFD examines the planned rate of growth in water demand and concludes that all water needs up to 2030 could be met from the planned reservoir. However, using the same data and accepting that a key feature of the design for the HGFD is that it should be able to store surplus water in years with above average rainfall (in the region of 2 billion m^3) in order to generate hydro-power in drought years, this SEA reaches a different conclusion. This is that the rate of planned growth substantially exceeds the capacity of the proposed water resource developments. The reasons for this conclusion are set out below.

It is accepted in the Feasibility Study that a total of 0.8 billion m^3 of water will need to be stored and released annually (in two discharges of 400 million m^3 each) in order to simulate the natural flood regime in the lower Tana. This estimate assumes a flood event of 7 days duration, which is a minimal requirement and does not represent the typical flooding event. In addition to storage of water for irrigation, flood discharges and power supply, the engineering studies confirm the need for minimum daily releases from the HGFD of 10m^3/second (865,000 m^3/day in the wet season) and 30m^3/second (2.59 million m^3/day) in the dry season. Taken over an average year this 'environmental' discharge amounts to 0.8 billion m^3 per annum. This again is based on figures for minimal flows in the lower Tana that have not be subjected to serious scientific investigation and cannot be confirmed as adequate for the intended purpose of protecting the ecosystems of the Primate Reserve and Tana Delta.

On the understanding that 2 billion m^3 of the annual storage (35%) is held back to cover the potential for a subsequent drought year, together with 0.8 billion m^3

Figure 3.2 Predicted Water Resources



(15%) to meet the twice yearly release of flood flows, the maximum amount of water available for use from HGFD for public and commercial water supply and irrigation will be 5.6 billion x 50% = 2.8 billion m^3. This is less than 65% of the forecast water demand by 2030 shown in table 3.2 and does not account for the fact that a further 0.8 billion m^3 (15%) is required to meet minimum environmental flows.

The inability of the planned HGFD to supply future water needs beyond 2030 is acknowledged in the Feasibility Study, which includes proposals for raising the dam in order to increase its storage capacity and increase power generation. There are also other potential dam sites in the Upper Tana Catchment which could be added to the existing cascade in the long term.

It is understood that a financial agreement is being negotiated between the Kenyan Government and Exim Bank of China and work is expected to begin soon on construction of the HGFD, which will take around 6 years to complete (Odhengo *et al*, 2012c).

3.5.2 Water Balance

It is the responsibility of the Ministry of Environment, Water and Natural Resources to balance supply and demand for water throughout the country and work is in progress on the National Water Master Plan, 2012. The following data is taken from a presentation made by Patrick Oloo, Deputy Director of Water Resources 21st February, 2013.

Climate change will have an effect on Kenya's water resources over the coming decades but it is not easy to calculate what the net impacts will be. Precipitation (i.e. rainfall) is expected to increase from the current level of 400 billion m^3 per annum to 441 billion m^3 by 2030 and 471.9 billion m^3 by 2050. However, evaporation is expected to increase at an even higher rate from 323.5 billion m^3 to 361.1 billion m^3 in 2030 and 388.3 billion m^3 in 2050. The net result is likely to be a slight increase in available water resources of 7 billion m^3. This gain has to be set against the projected rise in population from 38.5 to 67.8 and 96.9 million in the same period - see Figure 3.2.

The results of these projections show that although there will be a slight rise in the total amount of surface and ground water resources over the next 40 years, availability per head of population will decline from the present level of around 1,990 m^3 per year (2010) to 1187 m^3/year in 2030 and 883 m^3/year in 2050.

The following figures and tables show the relationship between the water resources available within each of the main catchments in Kenya, anticipated water demand by catchment and the current assumptions about balancing water demand with available supply. It will be noted that the Tana River Catchment is anticipated to have the largest demand for irrigation water at 5.7 billion m^3 per annum, although the data suggests that the developed area of irrigated land will require 3.6 billion m^3 per year by 2030.

Figure 3.3 Renewable Water Resources by Catchment in 2030

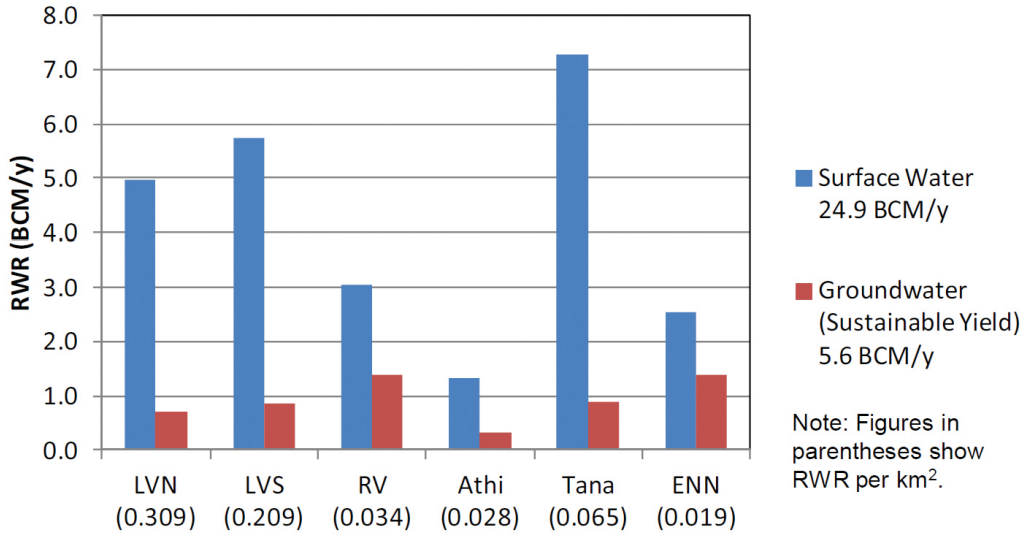


Table 3.3 Water Demand in 2030

(Unit: MCM/year)

Subsector	LVN	LVS	RV	Athi	Tana	ENN	Total	2010 Total
Domestic	427	460	264	941	343	125	2,560	681
Industrial	19	41	23	153	42	2	280	54
Irrigation	859	1,842	750	5,168	5,702	2,121	*16,442	2,027
Livestock	77	124	132	67	77	81	558	255
Wildlife	2	2	2	1	1	0	8	8
Fisheries	5	5	3	4	5	5	27	15
Total	1,389	2,474	1,173	6,334	6,170	2,334	19,875	3,040

Note: * Water availability has not considered yet.
Irrigation area is 1.2 million ha

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Figure 3.4 Water Demand by Catchment in 2030

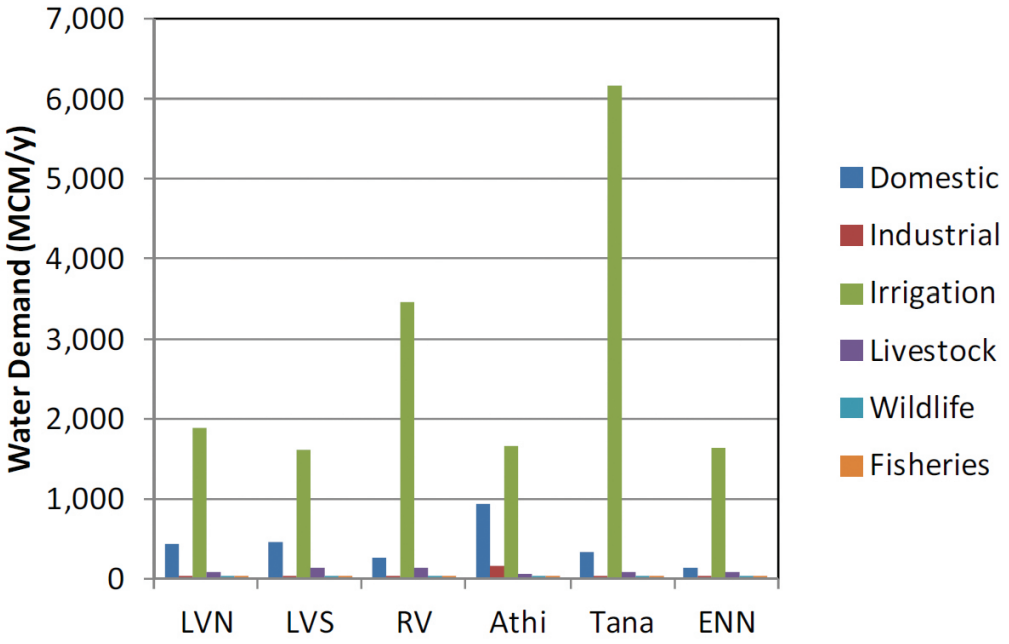


Table 3.4 Balanced Water Demands in 2030

Subsector	LVN	LVS	RV	Athi	Tana	ENN	**Total**
Storage Dams (MCM)	1,237	949	650	1,760	5,168	465	**10,229**
Small Dams and Pans (MCM)	109	33	42	30	34	50	**298**
Boreholes (MCM/year)	440	539	756	236	639	846	**3,456**
Inter-basin Transfer (MCM/year)	173	0	123	263	0	0	**559**
Intra-basin Transfer (MCM/year)	10	0	3	46	73	0	**132**
Desalination (MCM/year)	0	0	0	54	0	0	**54**

3.6 Hydrology

It has been clearly established through the scoping and baselines studies for the Tana Delta that the entire ecosystem, together with the culture, human welfare and livelihoods of the 102,000 people who live within the Delta, is inextricably linked to the flow regime of River Tana. While flooding imposes risks for people living in low-lying areas, it also brings natural silt fertilisers and water as the life blood of the Delta. Without annual (and preferably two season annual) flooding the Delta will dry up and cease to exist.

The way in which the High Grand Falls Dam is constructed and filled will be critical to the life of the Delta. Since the dam has a capacity to store the total runoff over one year from the upper catchment, it will be essential to ensure that the dam is filled over a number of years to avoid the river (and Delta) drying out completely during the filling period.

Once the dam is filled and goes into operation its primary function will be to provide power and water for irrigation. However, it will also need to be managed in such a way that artificial floods can be created twice a year by opening the sluice gates and allowing enough water to reach and flood the Tana Delta.

The Consulting Engineers who carried out the Feasibility Study for HGFD have made it clear that all of these objectives cannot be satisfied by a single dam since normal use for hydro-power generation and irrigation requires the daily release of large amounts of water which cannot then be stored for flood stimulation unless a second dam and reservoir are built down-stream. The purpose of the second dam is to trap the daily releases and re-store the water for alternative uses including flood simulation.

The Consultants have assumed that the initial development of the High Grand Falls Dam can proceed without impacting on the lower Tana River providing that the second dam is brought into operation by 2027. However, there have been no technical or scientific studies to prove that this assumption is correct. All the available evidence suggests the opposite, and the feasibility study's own environmental analysis confirms that the Delta will be severely affected without proper regulation of normal and flood flows.

3.8 Biodiversity

If the predicted developments outlined in previous sections come to reality the prognosis for the future health of the rich natural resources of the Delta are not good, despite the designation of the entire Delta as a Ramsar site of international importance.

The conversion of land from its natural state (grassland, scrub and woodland) to agricultural or intensive grazing land will reduce the physical area of prime habitat – as is already occurring through the recent destruction of Onkolde Forest. Rare primates and other sensitive species which seek to avoid the presence of man will be confined to areas that will ultimately become too small to support viable populations and extinction will follow. The conversion of 30,000 hectares of grassland to provide intensive grazing together with 10,000 hectares in the floodplain to support the extra 60,000 people will aggravate the existing conditions that impoverish the natural environment.

Loss of natural habitat will greatly reduce the ecosystem services enjoyed by the existing population as grass, reeds, fruits and medicinal plants become less accessible.

PART TWO: NATIONAL SCENARIO 2 - CHANGES FROM 2030 TO 2050

Attempts to forecast patterns of change up to 2050 are fraught with difficulty since these changes will not occur in a vacuum but will be heavily influenced by popular and institutional reactions to events as they unfold. Nevertheless, it is important to explore the issues since the future of the Tana Delta needs to be considered in perpetuity – not just for 20 or 40 years.

3.8 Population

Demographic experts expect the rate of population growth to slow beyond 2030, as people become more familiar with the benefits of family planning and rising standards of living lead to smaller household units in keeping with other emerging economies. Nevertheless official forecasts indicate that the population of Kenya is expected to rise from 67.8 million in 2030 to 96.9 million in 2050.

Given planned investment in the LAPSSET corridor, the Lamu sub-region will be one of the fastest growing parts of the country and at 3% growth per annum the population of the wider Tana Delta area would rise from 350,000 in 2030 to 614,000 by 2050. The equivalent rise in population in the Delta itself would be from 174,000 to over 315,000.

3.9 Livelihoods

The analysis set out in section 4.2.2 shows that by 2030 at existing population growth rates, 30% of the core delta (20,000 ha) would need to be given over to cattle rearing to support only the pastoralist members of the communities. In addition, 2,500-5000 ha would need to be converted to agriculture to support the increasing

farming population. Between 2030 and 2050, continued growth in population would lead to increasing pressure on finite resources of land. The capacity of the Delta to sustain its resident population would almost certainly be reached, if not exceeded, by around 2040 – even without the intervention of any other type of land use (i.e the conversion of land to commercial food and biofuel production).

In these circumstances, the only way that the entire increase in population within the Delta (125,000 people) could be accommodated by 2050 would be by reducing the current area of grazing land and converting this for intensive food production through communal farming. The total area of land needing to be brought into agricultural production would be between 10,000-25,000 hectares. This would however remove the same amount of land currently used for grazing, leading to the need for yet more conversion in order to feed displaced pastoralist families.

Once the capacity of the Delta to feed its own population has been exceeded the only options for local communities would be outward migration or adoption of new lifestyles with the wage earners in each family moving or commuting to Lamu and other industrial centres.

3.10 Social Welfare

The conditions outlined above in relation to livelihoods highlight in stark terms the realities of assuming that population growth can be allowed to continue indefinitely in the Delta. Even without the intervention of any external forms of development, competition for food and water amongst the inhabitants of the Delta would reach a crisis point long before 2050, based simply on the number of mouths to be fed. If other factors, like the increasing loss of productive land from rising sea level and reduction of fresh water to flush salts out of the coastal soils, are taken into account, it is clear that the social welfare of a large sector of the Delta population could deteriorate further from its current unsatisfactory position. Serious conflict would become unavoidable.

3.11 Economic Activity

The pressures outlined in preceding sections have been faced and are being faced in many other parts of the world and the short term solution lies in promoting industrial and commercial activity, as occurred in Europe in the Industrial Revolution and has been demonstrated by the 'tiger' economies of Asia and emerging countries like Brazil. However, as the search for places to grow food widens (as demonstrated by the recent interest of Middle East countries like Qatar in acquiring land in the Tana Delta), land with the highest potential to grow crops will come under increasing pressure and will become of ever increasing value.

If the economic vision for the new port of Lamu and the transport corridors to Sudan and Ethiopia comes to fruition, this will generate high potential for the import and export of a wide range of commodities including oil, food, textiles, machinery and other goods. It will also transform the character of a relatively remote and undeveloped part of the country into an urban and industrial metropolis. This new centre will demand water, food and raw materials in competition with the local needs of the Tana Delta and it is likely that the higher wages and commercial interests of the new citizens will command greater purchasing power than resident communities in the Delta.

The assumption has been made in Vision 2030, that the River Tana system is a largely unutilised resource that can be converted through large scale irrigation projects to feed the rest of Kenya and to strengthen the national balance of payments. However, to achieve these ends it will be necessary to demonstrate that the challenges outlined in the previous paragraphs can be overcome and the livelihoods of the indigenous population protected and enhanced.

The question therefore needs to be asked now – what lies in the best interests for Kenya and for the Tana Delta in particular – in terms of the way the Tana Delta's land and water resources are used?

3.12 Water Resources

3.12.1 Water Demand

It will be readily apparent that water demand will need to be curbed as the world's resources of fresh water are increasingly utilised and this is most likely to happen through increasing efficiency in water use and recycling. If population growth responds to Government policy and is brought under control within the next 20 years this could help limit water demand but expectations in terms of satisfying human needs for food, good sanitation and acceptable living conditions will continue to raise the overall consumption per capita.

Draft papers on the National Water Master Plan, 2012, show that without serious intervention, the population in Kenya may have risen to 96.9 million by 2050. Climate change is expected to lead to increased rainfall and higher rates of evaporation with the increases in precipitation being slightly higher than losses through evaporation. Increased use of ground water may also raise water availability for the country as a whole.

In the timescale of 2050, demands for food production could raise the irrigation demand in the Tana Delta to close to its maximum potential of 5,702 million cubic metres of water a year. This equates with the total storage capacity of the High Grand Falls Dam and would necessitate the building of further storage reservoirs in the Upper Tana Catchment. Other major water consumers including urban centres like Nairobi and the LAPSSET corridor would induce additional demands

3.12.2 Water Supply

The feasibility study for the High Grand Falls Dam considers a timescale of 40 years and anticipates that by 2030 it will be necessary to raise the height of the planned dam in order to meet continually rising energy demands. It also proposes the construction of the second dam and storage reservoir to distribute water for multi-purpose use. Reference is made to two other potential dam sites in the upper catchment of the Tana River basin that could be developed once the capacity of the HGFD has been exceeded.

3.12.3 Water Balance

All existing government policies make the case for sustainable use of natural resources, including water, in accordance with the Constitution; and yet any description of the likely demands for water and sources of supply in the River Tana Basin makes it clear that these conditions will not be achieved without radical re-thinking of both the development strategies and management and control of water resources in the catchment. This SEA concludes that a realistic water balance model needs to be constructed for the entire river basin which can be used to test alternative long-term options and formulate a more realistic set of national goals and objectives for water conservation and use.

3.12.4 Biodiversity

Preservation of the natural environment of the River Tana corridor (and the Tana Delta in particular) will be extremely challenging, given the range of development proposals that are under consideration for the upper and middle reaches of the river, and the potential diversion of water to service adjacent catchments. Two views can be taken on the changes that could occur between 2030 and 2050, the first, a pessimistic forecast and the second, a more optimistic view.

3.12.4.1 A Declining Resource

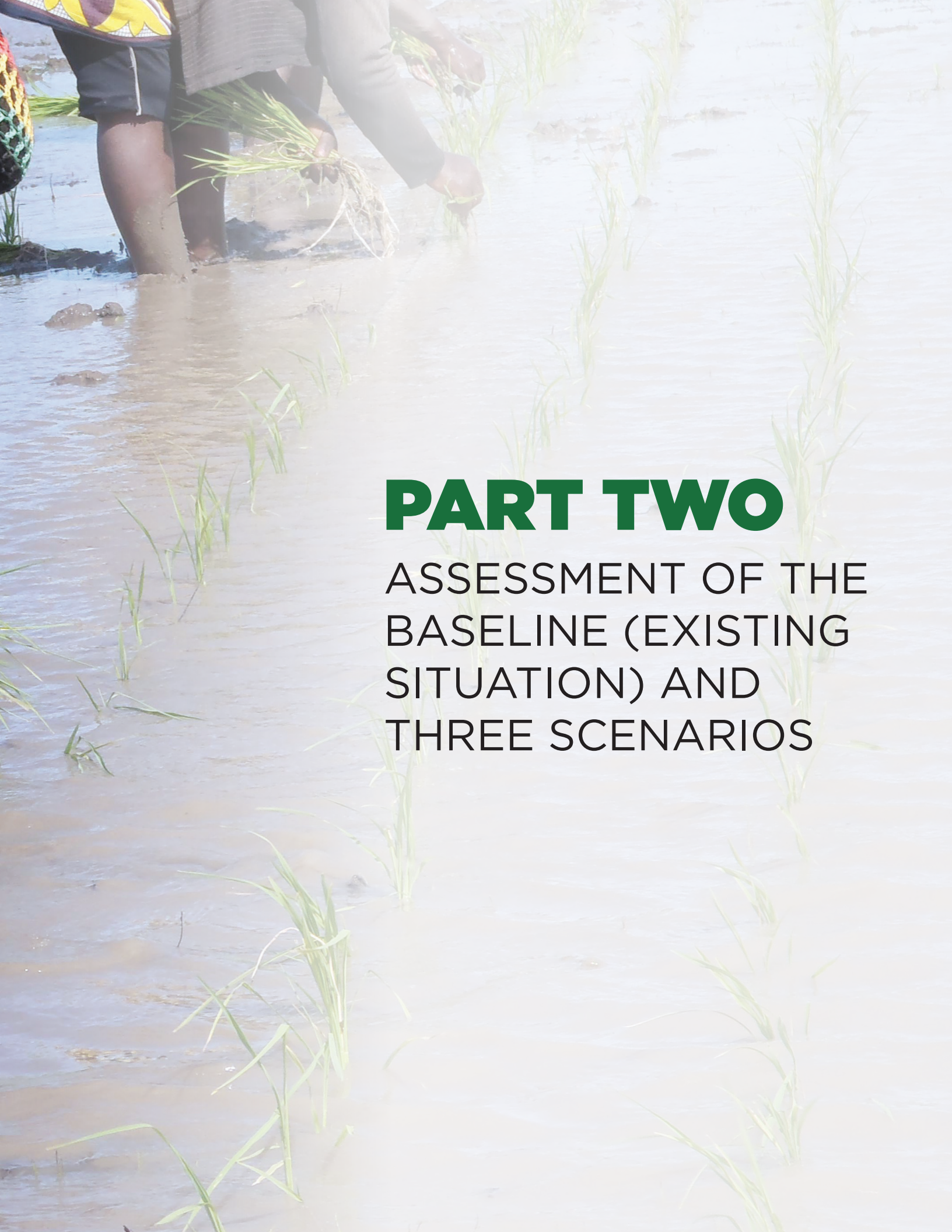
At the present time, no part of Kenya is spared from the attacks on elephants and rhinos by poachers intent on securing horns and ivory, and this includes the Lower Tana Delta where two KWS rangers were killed in shoot-outs close to Kipini in January, 2014. Over time, the migratory routes between the Tana Delta and other wildlife refuges are likely to come under increasing development pressure, while the natural grassland and forest habitats within the Delta and Tana floodplain will succumb to conversion to other land uses. This, in turn, will increase human – wildlife conflict. Climate change and reduction in river flows will add to adverse effects on wildlife. Despite efforts to protect the Tana Delta, lack of political commitment and resources, combined with continuing tensions between rival land-users, will ultimately lead to the loss of this internationally important wetland and the human cultures and traditions that are associated with it.

3.12.4.2 An International Success Story

The commitment and effort shown by the National Government in developing a land use plan for preservation of the Tana Delta and its communities will be sustained and intensified in the years ahead by the County and National Governments. Despite working through a period of significant local and national tensions, when many other pressing demands for resources existed, Government has already set new standards in conservation and in planning for the Tana Delta. These efforts will be transformed into a robust land use strategy for economic and sustainable development on the ground. Community-led agricultural and ecotourism initiatives will generate the funds to manage the wildlife habitats of the Delta, and exploitation of its natural resources within sustainable limits will continue to support its communities and their distinctive lifestyles. Development in the upper catchment will be carefully managed and regulated to ensure that good quality water is returned after use to the River Tana and the environmental reserve is maintained. Over time, the Tana Delta will become recognised as one of the international success stories in the conservation of the world's most precious habitats, meeting the needs of its own citizens while also increasing the stature of Kenya as a global tourism destination.

3.13 Conclusions

Regardless of decisions that are made locally to protect and manage the Tana Delta, major changes in the Delta's environmental, social and economic conditions are likely to follow development elsewhere in the River Tana basin and LAPSSET corridor. Most of these changes to the Delta will be adverse unless special measures are introduced to secure sustainable development elsewhere in the wider region. The Tana Delta Land Use Plan and SEA provide a model example of how to address such challenges, but this approach will need to be replicated throughout the Tana River Basin and in neighbouring Counties in order to deliver a sustainable future.



PART TWO

ASSESSMENT OF THE BASELINE (EXISTING SITUATION) AND THREE SCENARIOS

Preamble

Levels of Accuracy

Scenarios spanning time horizons of 20 and 40 years must inevitably be based on very wide ranging assumptions and there is no sense in which they can be regarded as giving an accurate picture. Instead their purpose is to illustrate likely trends.

Many calculations have been employed in building up each scenario. These are presented in great detail in the Tana Delta Land Use Plan. In each case the exact figures resulting from the calculation have been used – even though this may appear to give an unrealistic level of accuracy. However, rounding and averaging results would have made the task of cross-referencing between the three scenarios more difficult so the reader should bear in mind that all figures are no more than very general approximations.

All of the information that has been included in the description of the scenarios has been assembled for the specific purpose of projecting future change in the Delta. This has been done by taking firm information about the Delta wherever possible and extrapolating to 2030 and 2050. The results have also been tested by comparing findings from other published studies, as a form of triangulation, and have been found to be broadly compatible for the purpose of this assessment.

While the resulting descriptions are regarded as sufficiently accurate to meet the needs of the Land Use Plan and SEA they should not be transposed to other studies without first checking the validity of the underlying assumptions.

Introduction

This part of the SEA provides an assessment of the existing situation in the Tana Delta and considers how the environmental, economic and social conditions are likely to change under each of the three scenarios described in the land use plan. The assessment has involved analysing existing and future conditions against seven variables, or headline indicators, comprising:

- Land
- Water
- Jobs
- Value
- Nature
- Culture
- Security

These one word headings above provide shorthand descriptions for the seven indicators which cover all physical, social, economic and environmental conditions in the Tana Delta and the River Tana Basin. A fuller definition is given below. Four of the indicators have tangible values attached, while the remaining three have less easily quantified values.

Tangible (Measurable) Values

Land – Refers to the amount of land which is required for any given activity together with an indication of the extent to which development or other activities are likely to change the original or current state of the land; in other words the degree of transformation from its 'natural or current' state which is likely to occur. For example, conversion of wet grassland which is grazed by wild herbivores to a cattle ranch will have a relatively small impact on the range of plant species present (providing grazing pressures and fertiliser / pesticide inputs do not alter significantly) whereas conversion of the same area to intensive farming will largely destroy the natural habitat. If a large rice paddy is created some indigenous bird species and reptiles may continue to inhabit the area, because rice is itself a grassland species, but conversion to an industrial crop like sugar cane would cause total transformation with loss of all biodiversity.

Land is measured in square kilometres (km^2) or hectares (Ha). 100 hectares make 1 square kilometre.

Water–Provides a measure of water demand for the specific land use or activity in comparison with the natural state and examines the extent to which this demand could be met from available sources.

Water is measured in terms of million cubic metres (Mm^3) consumed in a year, or supported by a flow in cubic metres per second (m^3/sec).

Jobs–Provides a shorthand reference to two key issues. The first is the assessment of the number of full time jobs (FTEs) that will be created by the new activity compared with the existing situation. The second assessment is a measure of the extent to which existing livelihoods and employment is affected by the new development. In some cases, new development will be highly sustainable in preserving existing livelihoods while creating new employment opportunities. A good example is eco-tourism. In other cases, for example the introduction of industrial cropping, the new development may cancel out existing opportunities for subsistence farming, grazing and natural produce harvesting and the net result may be no net increase in jobs and livelihoods or even an overall loss in employment.

Jobs and livelihoods are measured in terms of a full time source of employment over one year (I FTE).

Value - The SEA has not attempted to undertake a cost-benefit analysis of individual activities and developments, since this would require much greater certainty about the types of operation that may be planned in the future than currently exists. However, it is important when weighing up the relative merits of different options to provide some indication of the scale of investment, turnover or financial yield which might be expected and this has been done for each activity.

Value is measured in terms of the gross capital investment in US Dollars for a particular enterprise, or gross value of stock or gross turnover or output in produce in a particular year.

Less Tangible Values

Each of the following indicators is covered by descriptive assessments of value:

Nature – This term embraces the natural environment and current conservation value of the habitats that make up this extraordinarily rich ecosystem. These values are harder to measure than other indicators because more variables are involved in terms of the physical extent of a habitat, its current 'condition', its inter-linkages with other parts of the ecosystem and its sensitivity and vulnerability to different pressures. Within individual habitats, and often spanning other habitats and ecosystems, are individual species of plants and animals which may be very rare and equally sensitive to change. Consequently, when assessing potential change in the Tana Delta it is also necessary to have regard to the dispersal and migration of plants, animals and birds by land, air and water, not only within the region but internationally.

Culture – Social well-being and cultural issues are bound up with the way in which communities see themselves and their future prospects. All aspects of daily life including use of land, access to water, livelihoods and employment and the status of the natural environment are important to a community's sense of self-respect and status, but other elements, including spiritual values, traditions and beliefs lie at the heart of most human societies and need to be respected when considering future change.

Security – The extent to which an activity supports or is in conflict with other land use activities and with social and cultural norms is of critical importance in areas like the Tana Delta where there has been a long history of inter-ethnic tensions over access to land and water. Security is used as a term to capture the overall sense of security in communities and their freedom from oppression or external challenges. It also encompasses the concepts of good governance, law and order and peace.

CHAPTER 4 Assessment of Existing Situation

Introduction

This chapter assesses the sustainability of the current situation in the Tana Delta Plan Area (as summarised in Chapter 3) and acts as a 'baseline' against which the assessments of Scenarios A, B and C in the following chapters can be compared.

4.1 Land

In order to assist in developing Scenarios, a summary of relevant information about the existing conditions was compiled. Table 4.1 and Figure 4.1 shows a simplified breakdown of the main vegetation and land cover types that make up the Plan Area while Figure 4.2 shows the same information, together with land use classes, in more detail. These diagrams illustrate that many needs are met from the same basic resources. The strategic environmental assessment of Scenarios A, B and C shows very clearly that if one land use is allowed to dominate over others, then all will ultimately suffer.

Table 4.1 Simplified Vegetation and Land Cover in the Tana Delta Plan Area

Simplified Vegetation/ Land Cover	Area (Km^2)
Forests, Thickets, Scrub, Mangrove	1,078
Agriculture	524
Floodplain grassland	508
Dunes	103
Water areas, Salt ponds	23
Urban	14
Total	**2,250**

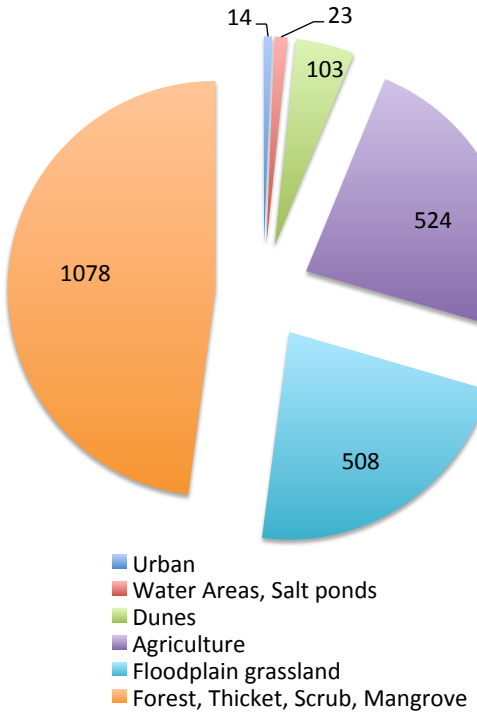
Source: Tana Delta SEA, 2014

Figure 4.2 highlights the importance of tree cover within the Plan Area which extends from dense riverine forest, open woodlands, thickets and scrub through to coastal mangroves. These vegetation types, when taken together, amount to almost half of the entire Plan area. The floodplain grasslands and areas which are nominally in use for all types of agriculture each take almost a quarter of the total area, with sand dunes, open water and urban areas accounting for less than ten per cent of the total.

In the Tana River Delta land use plan further analysis has been undertaken of the range of different land uses and economic activities considered in Scenarios A, B and C in order to assess how dependent their successful exploitation is on three key factors:

- Availability of land
- Availability of water
- Environmental Quality

Figure 4.1 Simplified Vegetation /Land Cover Zones with the Plan Area



Source: Tana Delta SEA, 2014

The results are shown in Figure 4.3. This analysis shows that availability of land is critical for all forms of agriculture, livestock rearing, natural resource use (including charcoal and fuel wood), nature protection and development of settlements. It is less important for bee keeping, fisheries, tourism, industry and commerce. Access to water is essential for agriculture, livestock rearing, fisheries, settlements and nature conservation. Other uses also require water but it is not needed in large quantities. Finally, a different set of land uses are highly dependent on high quality environmental conditions including bee keeping, fisheries, natural resource production, tourism and settlements. It is significant that the one land use which is dependent on all three resources is nature protection and the maintenance of biodiversity.

Figure 4.3 Importance of Land, Water and Environmental Quality to Specific Land Uses

Land Use / Economic Activity	Land	Water	Environmental Quality
Subsistence Farming	★★★★★	★★★★★	★★
Commercial Farming	★★★★★	★★★★★	
Livestock Rearing	★★★★★	★★★★	★★
Bee Keeping	★	★	★★★★★
Fish farming	★	★★★★★	★★★
Non Timber Forest Products (NTFP) Use	★★★★★	★★★	★★★★
Charcoal & Fuel Wood	★★★★★	★★★	★★
Tourism	★★	★	★★★★★
Nature Protection /Use	★★★★★	★★★★★	★★★★★
Settlements	★★★★★	★★★	★★★★★
Industry / Commerce	★★	★★	
Trading / Marketing	★	★	

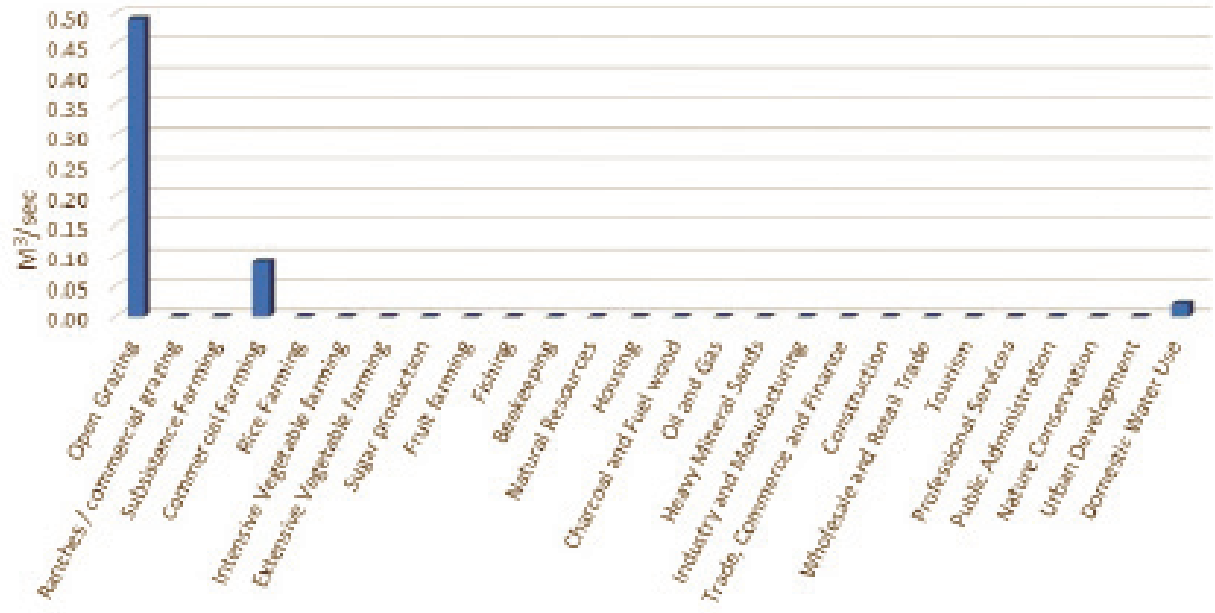
Importance of the resource to sustainable development 1 star = low; 5 stars = high

Source: Tana Delta SEA, 2014

4.2 Water

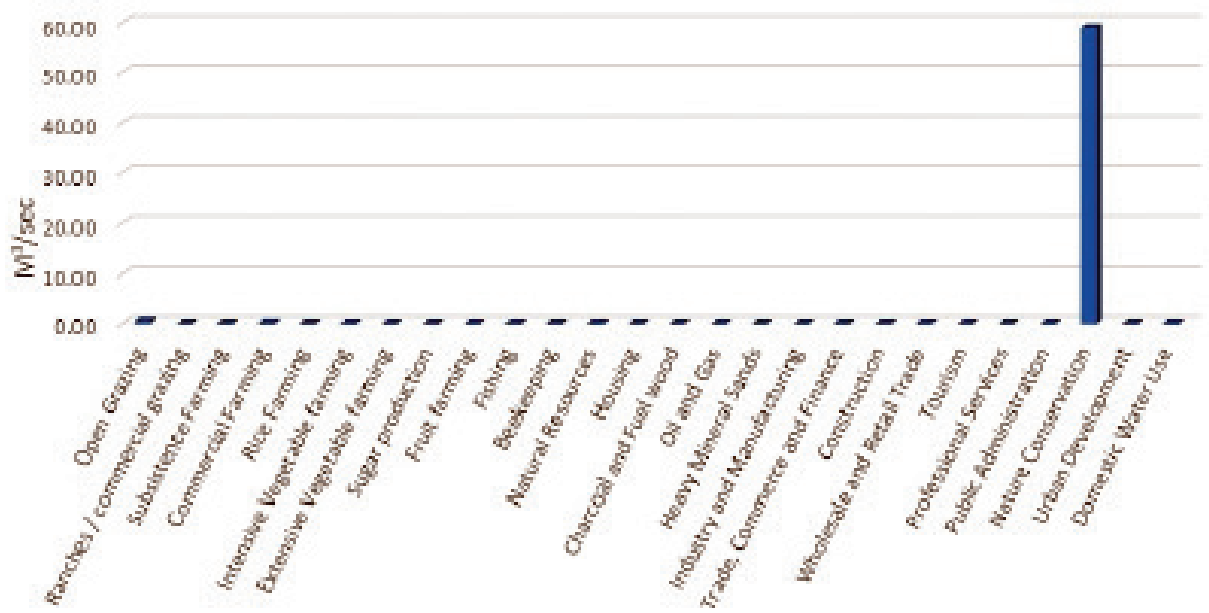
Figures 4.4 and 4.5 and Table 4.2 show the existing levels of water use and demand within the Tana Delta. The largest single use of water is in maintaining the natural condition of the Delta and is referred to as the environmental or ecological reserve. This has been estimated at 59m^3/sec for the areas of wet grassland, which equates to the mean flow in the River Tana. Historically, the Delta floodplain was inundated twice a year during the rainy seasons, but the frequency of this type of flooding has decreased with development of storage reservoirs in the Upper River Tana Basin.

Figure 4.4 Existing Water Use in the Tana Delta (Excluding the Environmental Reserve)



Source: Tana Delta SEA, 2014

Figure 4.5 Existing Water Uses in the Tana Delta including the Environmental Reserve



Source: Tana Delta SEA, 2014

Table 4.2 Existing Water Uses in the Tana Delta

Land Use Activities	M^3/sec
Open Grazing	0.49
Ranches/Commercial Grazing	0.00
Subsistence Farming	0.00
Commercial Farming	0.09
Rice Farming	0.00
Intensive Vegetable Farming	0.00
Extensive Vegetable Farming	0.00
Sugar Production	0.00
Fruit Farming	0.00
Fishing	0.00
Beekeeping	0.00
Natural Resources	0.00
Housing	0.00
Charcoal and Fuel Wood	0.00
Oil and Gas	0.00
Heavy Mineral Sands	0.00
Industry and Manufacturing	0.00
Trade, Commerce and Finance	0.00
Construction	0.00
Wholesale and Retail Trade	0.00
Tourism	0.00
Professional Services	0.00
Public Administration	0.00
Nature Conservation	59.01
Urban Development	0.00
Domestic Water Use	0.02
Totals	**60.00**

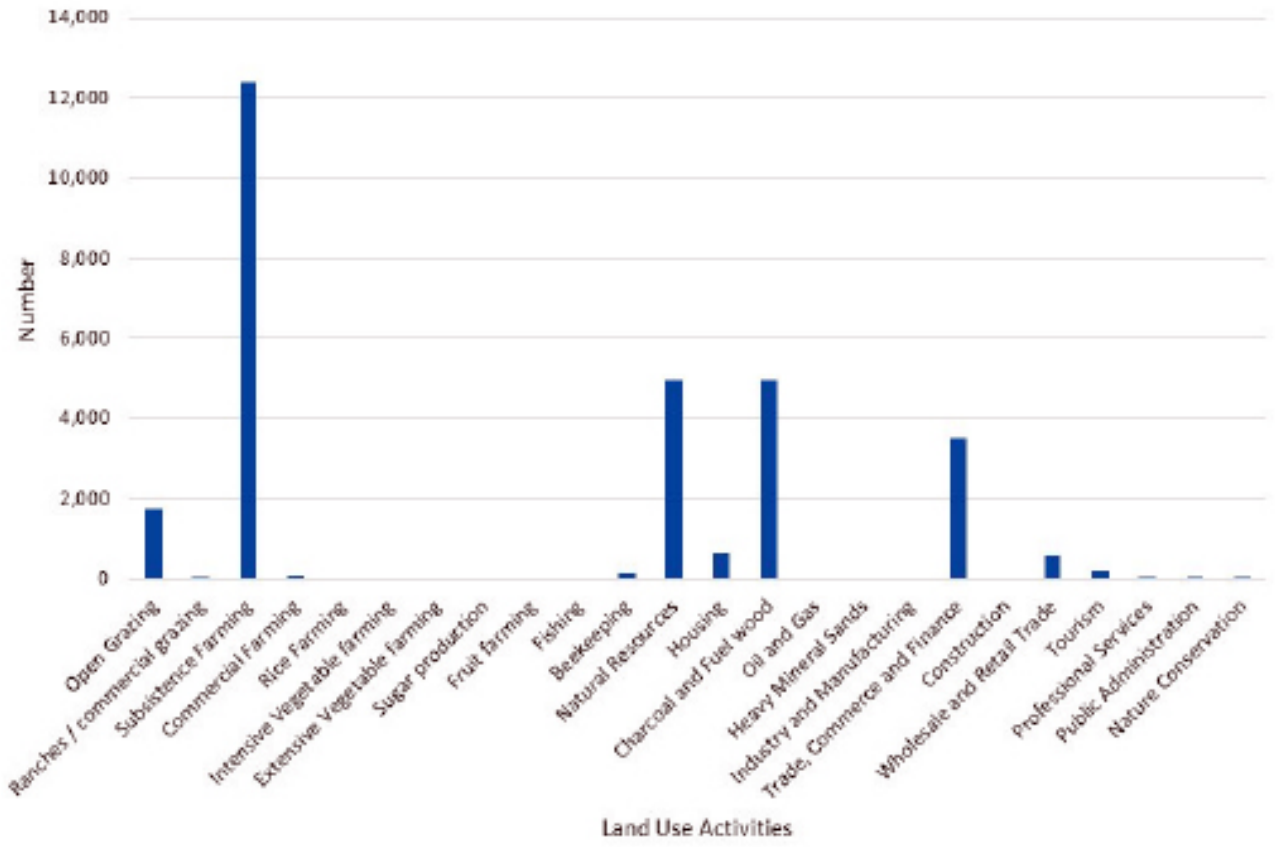
Source: Tana Delta SEA, 2014

Consequently, there are extended periods when the Tana Delta receives less water than it requires to maintain the habitats and particularly wet grasslands in optimum condition. During dry seasons, flows of fresh water in the River Tana can drop so low that saline water is carried by high tides up the river channel for more than 30 kilometres from the sea (Hamerlynck, 2012). Under these conditions, land used for livestock grazing and farming can be adversely affected by the accumulation of salts in the soil.

4.3 Jobs

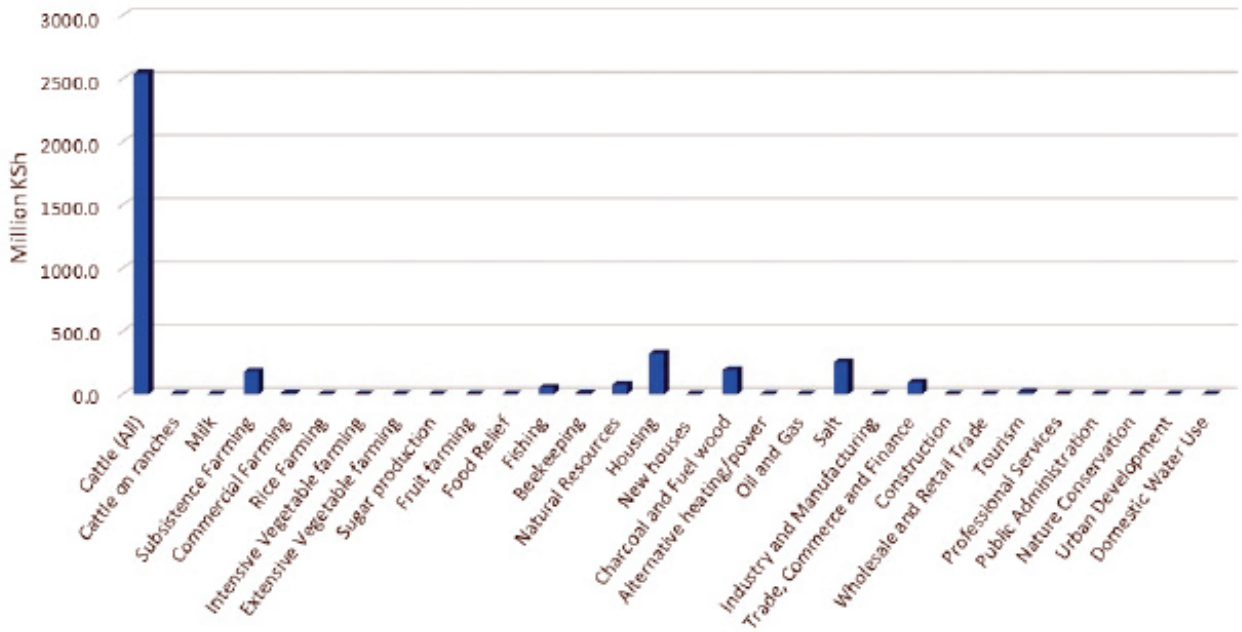
Figure 4.6 and Table 4.4 illustrate the estimate of the current number of jobs or livelihoods that exist within the Tana Delta. The largest component of 12,400 (41.6%) is provided by subsistence farming, followed by 10,600 (35.5%) in natural resources harvesting and the related activities of charcoal making, fuel wood collection and house construction. Other activities with significant job creation include cattle herding, trade and commerce. The estimated total number of full time job equivalents (FTEs) of 29,827 compares with the proportion of the existing population falling within the economically active age class which is 52,020 people. This suggests that the effective level of unemployment is 57%.

Figure 4.6 Existing Jobs/ Livelihoods within the Tana Delta (2010 Estimate)



Source: Tana Delta SEA, 2014

Figure 4.7 Value of Land Use Activity in 2010



Source: Tana Delta SEA, 2014

4.4 Value

Figure 4.7 and Table 4.3 show the estimated value of all land use activities in the Tana Delta in 2010. The gross value is shown as 3.7 billion KSh, but this figure is deceptive in that the major element represents the value at market rates of the entire cattle population, although less than ten per cent of these animals are traded in any one year. In consequence, the actual value of the local economy will be closer to 1.5 billion KSh.

Table 4.3 Value of Individual Land Use Activities in 2010

Land Use Activities	Existing
Open Grazing	1,736
Ranches/Commercial Grazing	2
Subsistence Farming	12,409
Commercial Farming	77
Rice Farming	0
Intensive Vegetable Farming	0
Extensive Vegetable Farming	0
Sugar Production	0
Fruit Farming	0
Fishing	575
Beekeeping	140
Natural Resources	4,971
Housing	633
Charcoal and Fuel Wood	4,971
Oil and Gas	0
Heavy Mineral Sands	0
Industry and Manufacturing	0
Trade, Commerce and Finance	3,488
Construction	0
Wholesale and Retail Trade	600
Tourism	200
Professional Services	5
Public Administration	0
Nature Conservation	20
Urban Development	0
Domestic Water Use	0
Totals	**29,827**

Source: Tana Delta SEA, 2014

4.5 Nature

The current condition of the Tana Delta fully justifies its status as a Ramsar site and one of the key hotspots for Biodiversity in Kenya and the whole of the East African coast. This status has been described more fully in the SEA Baseline Report and Chapter 3, The Situation Analysis in this report.

Threats to the special character of the Delta stem from reduction in flood flows and overall availability of water to maintain floodplain habitats, conversion of land to other uses including, principally, farming, degradation through excessive grazing and harvesting of natural resource materials. These issues are picked up under the assessment of individual scenarios.

4.6 Culture

The biological diversity and richness of the Tana Delta is matched by the cultural identities of the different ethnic groups who graze livestock, farm and catch fish or harvest natural produce within its boundaries. However, the well-being and survival of these distinctive cultures is threatened by the increasing difficulty of maintaining sufficient income, food and water from the natural resources of the Delta in the face of rising population, and pressures on the same resources in the upper sections of the River Tana Basin. An important question for this SEA is the extent to which maintenance of individual culture will be compatible in the long term with the need for development in the Delta to provide water and food security.

4.7 Security

Issues raised under the heading of culture apply with equal force to the questions of security and the measures that will need to be taken to reduce the existing high levels of tension that arise from time to time, particularly when competition for water and land for grazing and agriculture spills over into violence and physical conflict.

CHAPTER 5 Assessment of Scenario A

Introduction

Scenario A assumes that there will be continued development of traditional livelihoods within the Tana Delta over the next forty years. This development will need to accommodate continuing growth in population, although the stage will ultimately be reached beyond which the natural resources of the Delta become inadequate to support this local population, let alone any land uses that are intended to serve the wider needs of Kenya.

5.1 Assessing impacts on and Related to Land

5.1.1 Introduction

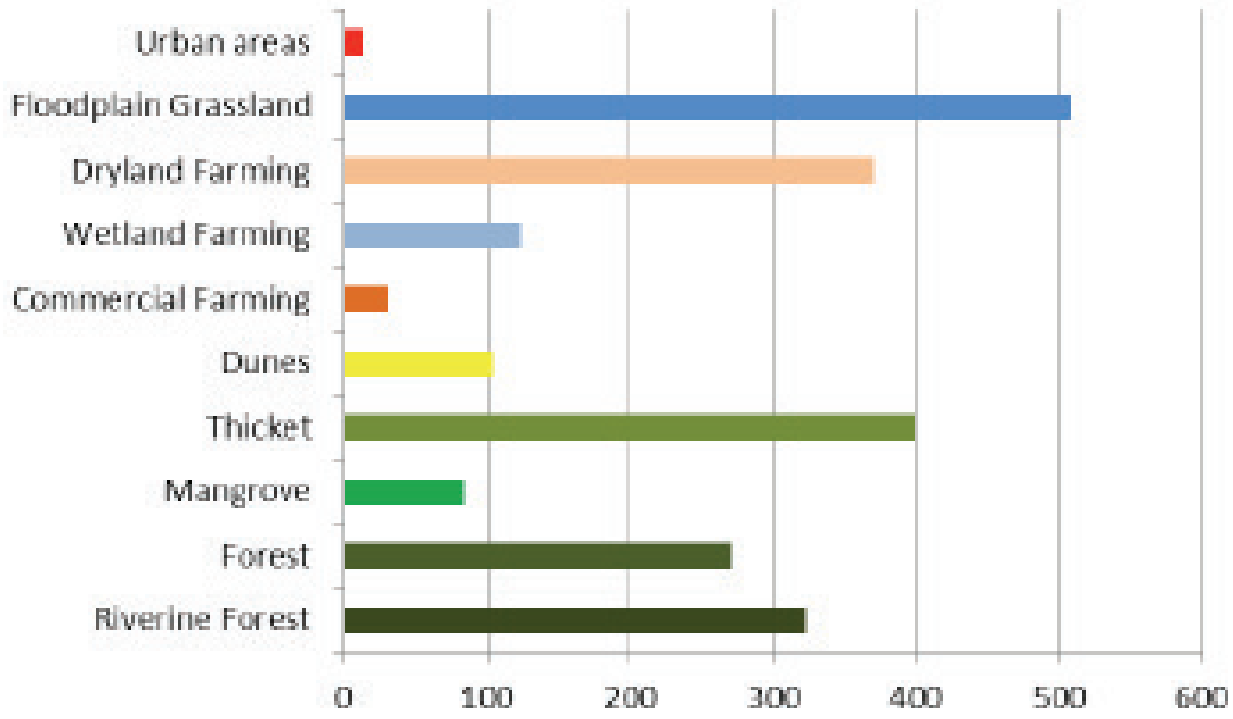
Figure 5.1 provides a breakdown of the existing distribution of vegetation and land cover within the Delta plan area.

The predominant uses of these areas are for grazing livestock, subsistence farming and gathering natural resource products. In terms of future development these three types of use would dominate the local economy under a strategy of supporting traditional livelihoods. There are strong aspirations within the Pokomo and Orma communities to increase their own specialist activities in farming and livestock rearing, but as the analysis reveals below, there are finite limits to the scope for bringing new areas of land which is currently under-used into production. Livestock rearing is concentrated on the wet grasslands of the floodplain, while permanent farming takes place close to the main river channels. All areas of the Tana Delta provide natural materials while the areas of thicket and scrub on the terraces are experiencing the highest rate of conversion through squatter settlement.

5.1.2 Population Growth and Land

The implications of population increase are cross cutting. Many of the requirements for additional land recorded under different types of land use activity are driven by population growth and the consequences are recorded under each activity in turn.

Figure 5.1 Existing Vegetation and Land Cover in the Tana Delta



Source: Tana Delta SEA, 2014

5.1.3 Livestock and Land

The Tana Delta is already functioning at close to its natural capacity in terms of the number of livestock that can be accommodated in the dry seasons. However, in order to test the resilience of the natural ecosystem and establish at what stage a breaking point would be reached, Scenario A assumes that cattle numbers will continue to increase in direct proportion to the number of new pastoralist households being added to the population in the Delta each year. On this basis, the number of resident cattle required to maintain the status quo in terms of animals per household would have to rise from 211,000 a year (2010) to 357,000 in 2030 and over 645,000 in 2050 (Odhengo *et al*, 2014b).

Distribution of cattle within the Delta in 2010 was assumed to be 2.1 cattle per ha in the floodplain (100,000 x 2.1= 210,000). However, this capacity cannot be exceeded without permanent damage to the wet grassland, so any subsequent increase would need to be met in the thicket and scrub of the terraces where the carrying capacity has been assumed to be one animal (cow) to three hectares (Odhengo *et al*, 2014b). If the entire area of the thicket and scrub land use zone were to be given over to cattle grazing this would allow grazing for 13,333 animals over 40,000 ha indicating that the maximum size of the permanent herd in the Delta could not exceed 225,000 head (Odhengo et al, 2014b). It should be noted that use of all areas of thicket and scrub for livestock rearing would have a significant impact on the existing population in these areas who cultivate small unfenced patches of ground as their main livelihood. In practice, much of the floodplain grassland becomes waterlogged and unsuitable for cattle (and other livestock) during the rainy seasons, so during these periods permanent herds have to be moved onto the terraces and into the Delta Buffer Zone.

Any further increase in the size of the permanent cattle herd could only be achieved by taking over existing farmland. While this is clearly an impractical option, the question has been asked "what would be the effect of converting all areas currently used for wetland farming (12,300 ha) and dryland farming (370,000 ha) back to grassland?" The answer is that this would provide sufficient grazing to allow a further 26,000 cattle in wetland areas and 123,000 cattle in dryland areas to be added to the permanent herd giving a total of around 360,000 animals (Odhengo *et al*, 2014b).

These calculations show that, ignoring all other land use interests, the maximum size of a permanent cattle herd in the Delta would be reached by 2030, but this would be at the expense of displacing all existing users of thicket and scrub, and wetland and dryland farming areas; in other words all farmers (more than half the population) would lose their livelihoods and be forced to leave the Delta.

Taking into consideration the parallel needs for additional land to be allocated for farming and crop production in order to feed the other 50% of the rising population who rely on agriculture rather than livestock for their livelihoods, it is clear that there is no way in which either all of the thicket and scrub, or indeed any areas of existing farm land, could be converted to cattle grazing without causing:
1) Widespread food shortages,
2) Massive social unrest.

The evidence is clear that the permanent cattle herd in the Tana Delta has already reached its maximum size and every effort should now be made to discourage any increase in cattle numbers. In the light of these findings, a variant (A1) of Scenario A was introduced which assumes that cattle numbers will remain static.

5.1.4 Agriculture and Land

5.1.4.1 Subsistence Farming

The demand for land for cattle rearing is matched by an equally strong demand for land for subsistence and commercial farming. Under the existing situation, a high proportion of the population in the Tana Delta do not have enough food to eat and around 15% are dependent on government food aid to supplement what they can grow on their own land (Odhengo *et al*, 2014b). With each generation, land in private ownership is subdivided between the children (sons) and the stage has already been reached at which the average household plot of land is only 1.5 acres (0.6 ha) (Odhengo *et al*, 2014b).

On the assumption that, with rising population, future households will require a minimum of 1.5acres (0.6 ha), the amount of land under subsistence farming would need to increase from the present level of 62km^2 to 104km^2 in 2030 and 189km^2 in 2050 (Odhengo *et al*, 2014b). To put these figures in perspective, the current areas of subsistence farming represents only 2.8% of the Delta. Growth of subsistence farming by 2030 would lead to this percentage increasing to 4.6%, and by 2050 8.4% of the Delta would need to be converted to subsistence farmland (Odhengo *et al*, 2014b).

In order to provide for full self-sufficiency in food it would be necessary to allocate 3 acres (1.2 ha) rather than 1.5 acres per household. This would result in increased demand for the conversion of land to subsistence farming of 502Km^2 (22.3% of the Delta) by 2030 and 909 km^2 (40.4% of the Delta) by 2050 (Odhengo *et al*, 2014b).

5.1.4.2 Communal Farming

Individual subsistence farming forms only a small part of overall agricultural activity and larger areas are cultivated by individual farmers and community groups in the wet land and dry land farming areas. These currently account for an estimated 123 km^2 (5.5 % of the Delta) and 370 km^2 (16.4 % of the Delta) respectively (Odhengo *et al*, 2014b). Further expansion of both of these areas can be anticipated under Scenario A. Based on pro-rata increase with rising population, the area of wet land farming would increase to 209km^2 by 2030 and 378km^2 by 2050, while the dry land farming would expand to 626km^2 in 2030 and 1134km^2 in 2050. These figures are based only on the pro-rata demand that would be generated by population growth and do not reflect whether the land is actually available to meet the need, which is assessed in the summary below (Odhengo *et al*, 2014b).

5.1.4.3 Commercial Farming

Only a small area of land in the Delta is farmed commercially by TARDA. The current cropping area is less than 20km^2 . This area would not expand under the traditional livelihoods approach explored in Scenario A (Odhengo *et al*, 2014b).

5.1.4.4 Irrigation

One of the key issues for the Tana Delta is how to make the use of existing farmland more productive. This can be achieved by increasing the use of fertiliser and other inputs, improving crop strains and increasing access to water in the dry seasons. Irrigation constitutes one of the ways of increasing food production by improving yields (provision of the required additional water could double or even treble most crop yields) and by allowing two or more crops to be grown each year. There is therefore a strong case for exploring opportunities for appropriately sized local irrigation schemes. Under Scenario A, the present area of irrigated land (385ha) would be increased to1000ha by 2030 and to a total of 2000ha by 2050 (Odhengo *et al*, 2014b). This amount of land could be found within the areas already affected by previous infrastructure development.

5.1.4.5 Summary of Agricultural Development

The cumulative effect of expanding subsistence and communal farming areas as outlined above would result in 1337 km^2 of agricultural land (59.4% of the Delta) by 2030 and 2421 km^2 of agricultural land (108% of the Delta) by 2050 (Odhengo *et al*, 2014b). Previous assessments have shown that the maximum cultivable area of the Delta is unlikely to be more than 1125km^2 (50%) of the Delta (Hamerlynck, 2010). In addition, 30% of the Delta is regularly inundated by flooding and a further 50% consists of protected areas and gazetted forests (Hamerlynck, 2010). Consequently, the threshold of agricultural development in terms of available land area would be reached before 2030, while the growth predicted to 2050 would be simply impracticable even if no other factors were involved in decisions about future land use. Just as uncontrolled increase in the size of the cattle herd would displace farming, so uncontrolled expansion of agriculture would decimate livelihoods based on livestock rearing.

The scale of the challenges facing the existing population in the Tana Delta are very great without even considering other demands for land which are generated by outside interests, including foreign investors, government agencies and private companies. At the core of the issues on land allocation is the fact that land suitable for grazing is also suitable for some types of farming (although these are limited by natural flooding). These areas of wet grassland also have some of the highest values in terms of biodiversity.

Conclusions and Recommendations: In considering the options that are open for managing agricultural land use the SEA draws a number of conclusions and recommendations:

1. Continued growth in population must have a finite limit and without any other intervention it is estimated that the sustainable threshold lies around a population of 170,000 which will be reached at current growth rates by 2030.
2. If population growth cannot be contained, outward migration will need to be encouraged for those residents who are economically active to growth centres like the port of Lamu and other parts of the LAPSSET corridor where employment might be available.
3. An agreed formula for sharing land between farmers and pastoralists needs to be at the heart of the land use strategy in the Delta.

5.1.5 Urban and Rural Development and Land

There is a low level of urbanisation in the Delta with less than 5% of the population currently living in towns (Odhengo *et al*, 2014b). But a fast transformation is underway; for example Garsen is expanding rapidly and has been designated as the second settlement (after Hola) in Tana River County. Witu is also expanding in Lamu County.

Urban Areas: Projections for population growth and household formation indicate that the current area that may be classified as urban which amounts to 26km^2 will rise to 45km^2 by 2030, and 80km^2 in 2050 (Odhengo *et al*, 2014b). The areas of growth are likely to be concentrated on established centres which already have services and

infrastructure, namely Garsen, Tarasaa/Ngao, Kipini and Witu. From initial inspection there should be no difficulty in allocating sufficient land in each location. However a major challenge with all land use allocations arises from the likelihood that squatters may set up permanent homes within the intended growth areas long before the land is needed for expanding population.

Conclusion and Recommendation: The SEA concludes that much stronger regulation and control needs to be exercised over allocated urban site areas to prevent squatting and unauthorised development.

Rural housing: The existing distribution of rural settlements in the lower Delta is strongly influenced by the hydrological conditions which existed over the previous 50-100 years (Hamerlynck, 2010). More than 30 of the 106 villages within the plan area are located along the former main course of the River Tana, which has now been downgraded to a secondary channel as a result of the Matomba Brook diversion opened in the late 1980s. Expansion of these villages will undoubtedly occur but the questions that will need to be addressed as the population grows are as follows:

1. How will these villages provide themselves with sufficient land for subsistence farming given that there are existing pressures from the density of population along this corridor?
2. Are there any practical solutions which could be offered to supplement the declining flows in the former main river channel during the dry season which is a serious limitation on crop yields?
3. How should these villages respond to the rising levels of salinity in surrounding farmland which is caused by reduction in fresh water flows and increased tidal range stimulated by global warming?

These issues will require detailed research but if conditions continue to become both more complex and more extreme it may be necessary to explore relocation of some communities. Part of the pressure might be relieved if an active programme was put in place to encourage some newly forming households to develop new areas rather than physically moving existing settlements.

Elsewhere in the Lower Tana Delta there are several isolated communities which have been created in seasonally flooded grassland. These settlements will usually have been formed as temporary shelter while grazing livestock but have become semi-permanent (Nyunja, 2013).

Conclusion and Recommendation: There are clear and justified reasons why settlements have already emerged in isolated areas of the floodplain. However, as a general principle, formation of new isolated settlements in areas of high flood risk should be actively discouraged. This recommendation is made partially on the grounds of health and safety, partially to protect the viability of other land uses including biodiversity but also in recognition that supporting isolated settlements with infrastructure and services is very much more expensive than developing those villages which are already close to the main road network.

Village location has been greatly influenced by past flooding events and more than half of all villages in the Delta have been relocated at least once in their history. It would be desirable for all new settlements to be located on higher ground within the terraces which fringe the Tana Delta, providing economic activities and livelihoods can be developed and enhanced.

5.1.6 Fishing and Land

To date, pressures on land use and access to land within the Delta have not had a major impact on fresh water fisheries. However, diversion and storage of water in the Upper River Tana Basin has severely affected river flows and the recharge of natural oxbow lakes. In future, uncontrolled migration of people encouraged by LAPSSET and other developments, including the erroneous assumption that there is 'free land' at the coast, could all reduce the availability of suitable areas for fishing.

There are very rich fisheries in the Bay of Ungwana (Formosa) and these are exploited to a limited extent by fishermen from Kipini. However a major constraint is the lack of any harbour facility at the mouth of the River Tana, the very dynamic environment in the estuary where high tides and storms are increasingly causing coastal erosion; and the challenges of taking small craft to sea through the surf zone which is often rough especially during the monsoon season. Commercial fishing boats currently stop at a rocky islet well offshore.

Conclusion and Recommendation: A land use policy/ planning statement should be developed to protect existing fishing areas and to encourage the development of fishponds or artificial lakes. Finding the appropriate land should not be a significant constraint providing it is carried out before 2020.

5.1.7 Beekeeping and Land

There is no problem in finding land on which to establish bee hives at present and there are major opportunities to extend the areas in which beekeeping is practiced.

Conclusion and Recommendation: The continued productivity and health of bees will be dependent on maintaining suitable forage crops including nectar

bearing trees and leguminous crops and protecting forest areas from damaging activities like over-grazing and charcoal production.

5.1.8 Natural Resources and Land

The natural resources of Tana Delta are already under pressure from land transformation, including reduction in the total area of forest, thicket and scrub from burning and felling to create additional farmland and from increased grazing.

The existing situation analysis suggests that an area of between 55-85 km^2 of scrub/thicket, forest and woodland is required in order to produce the current amount of charcoal and fuelwood sustainably. With rising population this level would increase to between 96-150km^2 by 2030 and to 174-271km^2 by 2050. (Odhengo *et al*, 2014b).

Given that existing production levels are already leading to significant deterioration in the quality and condition of all woodlands and wooded habitats within the Delta, it is clear that the situation would deteriorate very significantly by 2030. Continuation of the trend to 2050 would undoubtedly destroy most of these important habitats. In practice a point would be reached where the loss of biomass would make it impossible to sustain production levels. This point could be reached within one to two decades. However even if production levels started to decline the opportunity for natural regeneration of wooded habitats could have been seriously weakened by loss of seed bearing plants, soil quality deterioration, soil erosion, etc.

5.1.9 Trade, Commerce, Finance and Land

Land is not an issue in relation to these economic activities at present.

5.1.10 Tourism and Land

Land is not an issue at present but this would change over the plan period under Scenario A. Significant population growth will lead to expansion in the areas of cultivation, extension of grazing land and increased production of natural resources (principally fuelwood), resulting in increased pressures on remaining habitats and loss of biodiversity. Under these conditions the prospects for expanding tourism based on the Delta's exceptional environment would be very limited. However, looked at in a more optimistic light and assuming that a proper balance can be struck between the needs of agriculture, livestock and natural resource use, the Delta would offer an excellent opportunity for promoting ecotourism. This option is explored separately in Scenario C (the Hybrid).

Conclusion and Recommendation: Ecotourism has considerable potential to create new livelihoods and employment and should be actively promoted under the Tana Delta Land Use Plan.

5.1.11 Industry, Mining and Land

Salt recovery takes place in a small area of the Tana Delta and there are other areas where sea water could be evaporated to provide salt although this would inevitably have implications for other land uses and the status of mangrove and other sensitive marine habitat in the coastal zone.

Conclusion and Recommendation: The SEA considers that the existing salt extraction works can be managed within the ecosystem but any increase in surface area should be considered very carefully and should only be authorised after a full environmental impact assessment has confirmed that its economic value would outweigh any adverse environmental effects.

5.1.12 Biodiversity and Land

Analysis of competing land use pressures shows that the exceptional richness of biodiversity in the Delta is most at risk from:

- conversion of wet grassland to food production areas,
- conversion of thicket and scrub to dry land (rain fed) agriculture,
- excessive grazing,
- loss of forest, mangrove and other key woodland habitats through conversion and unsustainable natural resource harvesting,
- a decline in overall water supply to the Tana Delta, both in terms of the extent and duration of flooding and increased stresses created during the dry seasons.

If the sequence of events outlined for other land use activities becomes a reality it is clear that the Delta will lose a significant proportion of its primary habitats by 2030 and it is arguable that at some point between 2030 and 2050 it would no longer warrant its status as an internationally important wetland. Table 5.1 summarises where the main impacts are likely to occur if population growth and land conversion and transformation remain uncontrolled.

The table shows only the likely effects of uncontrolled agricultural expansion, which includes the loss of most existing forest areas (down to 18% of current cover), the reduction in floodplain grassland to half its current size and the virtual total loss of areas of thicket and scrub on the terraces.

Table 5.1 Potential Impacts from Expansion of Agriculture and Urban Areas on Important Habitats by 2030 and 2050

Land Class / Habitat - Areas in Km^2	2010	2030		2050	
	Existing Area	New Area	%age of existing	New Area	%age of existing
Forest	271	271	100	50	18
Riverine Forest	323	323	100	123	38
Mangrove	84	84	100	74	88
Thicket & Scrub	400	126	31.5	10	2.5
Floodplain grassland	508	422	83.1	253	49.8
Wet land farming	123	209	170	378	307.3
Dry land farming	370	626	69.2	1134	306.5
Commercial farming	31	31	100	31	100
Dunes	103	103	100	103	100
Urban areas	14	32	228.6	71	407
Water areas	18	18	100	18	100
Salt ponds	5	5	100	5	100
Totals	2250	2250	100	2250	100

Source: Tana Delta SEA, 2014

Equally significant would be the pressures from increased grazing and foraging for natural resources on the remaining habitats.

5.2 Assessing Impacts on and Related to Water

5.2.1 Introduction

All economic and land use activities generate a need for water somewhere or have impacts on water, land and livelihoods, but in strategic terms the focus needs to be placed on the main demand generators. In Tana Delta, 5 out of the 14 land use categories dominate the issue of water demand; these are:

- growth in population,
- livestock rearing,
- agriculture,
- irrigation, and,
- biodiversity.

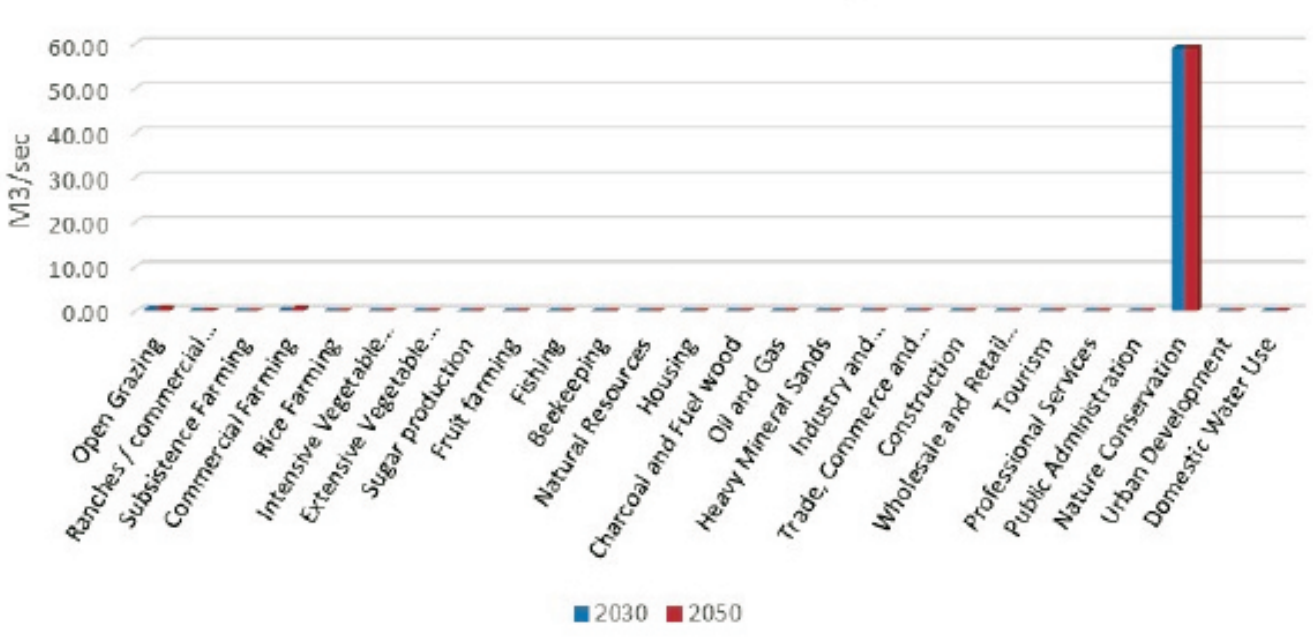
See Figures 5.2 and 6.3 and Table 5.2

Table 5.2 Scenario A- Daily Water Consumption in M^3/day for Main Land Uses

Scenario A 2030	2030		2050	
	Annual Mm^3	M3/sec	Annual Mm^3	M3/sec
Open Grazing	17	0.53	20.74	0.66
Ranches / commercial grazing	2.96	0.09	5.35	0.17
Subsistence Farming	0	0.00	0	0.00
Commercial Farming	9.85	0.31	20	0.63
Rice Farming	0.00	0.00	0	0.00
Intensive Vegetable farming	0.00	0.00	0	0.00
Extensive Vegetable farming	0.00	0.00	0	0.00
Sugar production	0.00	0.00	0	0.00
Fruit farming	0.00	0.00	0	0.00
Fishing	0.00	0.00	0	0.00
Beekeeping	0.00	0.00	0	0.00
Natural Resources	0.00	0.00	0	0.00
Housing	0.00	0.00	0	0.00
Charcoal and Fuel wood	0.00	0.00	0	0.00
Oil and Gas	0.00	0.00	0	0.00
Heavy Mineral Sands	0.00	0.00	0	0.00
Industry and Manufacturing	0.00	0.00	0	0.00
Trade, Commerce and Finance	0.00	0.00	0	0.00
Construction	0.00	0.00	0	0.00
Wholesale and Retail Trade	0.00	0.00	0	0.00
Tourism	0.00	0.00	0	0.00
Professional Services	0.00	0.00	0	0.00
Public Administration	0.00	0.00	0	0.00
Nature Conservation	1861	59.01	1861	59.01
Urban Development	0.00	0.00	0	0.00
Domestic Water Use	2.50	0.08	4.6	0.15
Totals	**1,893**	**60.02**	**1,912**	**60.62**

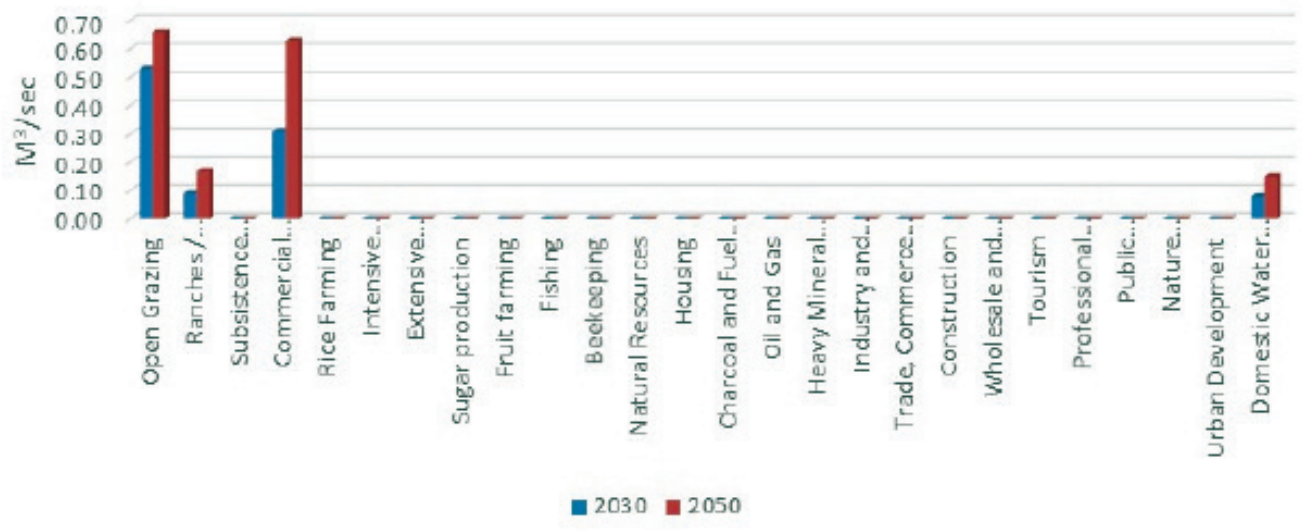
Source: Tana Delta SEA, 2014

Figure 5.2 Daily Water Demand for Main Land Use Activities



Source: Tana Delta SEA, 2014

Figure 5.3 Water Demand for Land Use Activities (excluding Nature Conservation)



Source: Tana Delta SEA, 2014

5.2.2 Population and Water

Under Scenario A opportunities to improve water supplies to isolated communities would be restricted by the low level of economic activity and lack of funding for infrastructure. With rising population, competition for water would increase. Traditional sources of water in the dry seasons, including wells dug in dry river channels and depressions, would be exposed to higher risks of contamination and pollution from both animal and human wastes. Urban areas would be less exposed to risks of water pollution than rural communities.

5.2.3 Livestock and Water

Livestock are not one of the largest consumers of water, but the need for animals to be herded to drinking points on a daily basis has become one of the most contentious issues dividing the pastoralist and farming communities. This is because cattle, goats and sheep invariably stray from the drove roads and are attracted to the richer vegetation and crops within farming areas, thus causing damage to standing crops. This is probably the single most important cause of conflicts within the delta, coupled with competition for land.

As a secondary consideration, a constant supply of river water is required to maintain the wet grasslands of the floodplain, especially in the dry seasons. Reductions in river flow have a direct impact on the availability of water to sustain grassland and lead to poorer and slower growth rates which has a direct impact on foraging cattle.

5.2.4 Agriculture and Water

At the present time the amount of water taken up by subsistence farming within the Tana Delta does not represent a significant burden on the dry season River Tana flows, (representing less than 0.5% total discharge) since individual farmers rely on rain or recession conditions to feed their crops and water availability is governed principally by location and soil type. However, the significant increase in farmland anticipated under Scenario A would lead to higher demands over the plan period.

5.2.5 Irrigation and Water

At the present time, irrigation in the Tana Delta takes place at a very small scale (around 350ha) split evenly between the TARDA rice project and irrigation scheme run communally by Hewani village (Emerton, 2003). The amount of water used is estimated to be <10% of water used for agricultural purposes and is of no significance in terms of River flows. However, it should be noted that the infrastructure constructed by TARDA in 1980s was intended to service a much larger area and most of this land is lying idle following the collapse of the dykes and infilling by natural erosion of drainage and irrigation canals. Under Scenario A it is assumed that only that part of the irrigation scheme lying to the west of the Garsen-Witu road would be brought back into full irrigation.

5.2.6 Urban and Rural Development and Water

Significant growth in urban areas is anticipated and this will lead to increased water consumption for domestic and commercial uses. However, in the overall context of water demand, urban uses would not put a significant strain on the available supplies.

5.2.7 Fishing and Water

Under Scenario A it is envisaged that freshwater fisheries will be expanded at a modest rate over the plan period with yields increasing from 394 tonnes to 500 tonnes in 2030 and 750 tonnes in 2050, almost a doubling in production over the plan period.

Conclusion and Recommendation: For these conditions to be realised there would need to be a significant improvement in low river flows, brought about by the construction of a regulating reservoir in the middle reaches of the River Tana (in addition to the High Grand Falls Dam). Without this development it is most unlikely that fish output could be increased within the Delta.

5.2.8 Beekeeping and Water

Water is vital in the maintenance of bee colonies because large quantities of water are carried to the hive in order to dilute honey for feeding to larvae and for use in cooling the colony through fanning. However, the amount of water required is insignificant in relation to river flows. If, however, long periods of drought occur, bees' ability to forage and to find water is greatly reduced. The flow of nectar is directly related to flowering periods of trees, which are the principal source of honey, and the volume of nectar is dependent on water uptake and temperature. In drought conditions, nectar flows cease. Consequently, honey production does depend on maintenance of the natural habitat and good ecosystem health.

5.2.9 Natural Resources and Water

Maintenance of a healthy ecosystem and individual habitats like forests, swamps and mangroves, is essential to productive management and use of grass and reeds for thatching, lianas for rope making, poles for housing construction and a wide variety of foodstuffs and medicines. The health of these habitats will be almost entirely dependent on a continuing reliable flow of river water, the management of grazing pressures and control of land conversion to other uses. Unless population growth is brought under control during the plan period it is highly likely that these conditions will not be met and the scope for utilising natural resources will decline rapidly as the habitats themselves are degraded or lost.

Conclusion and Recommendation: Every settlement should be encouraged to develop its own plan for conservation and management of the habitats on which it relies for raw materials within an over-arching management plan for the Ramsar site.

5.2.10 Trade, Commerce and Finance and Water

At the present time, the provision of water in plastic bottles and sachets is not a significant economic activity although the development plan indicates 300 individuals are engaged in selling water (Government of Kenya, 2008). This is potentially very significant for future development, but only if income levels are raised as a result of economic stimuli. Under Scenario A it is unlikely that these conditions will be met.

5.2.11 Tourism and Water

Current levels of tourism activity have no impact on water resources although access to clean water is vitally important in creating tourism resources. The condition of the River Tana and habitats within the Tana Delta is also crucial to the future development of eco-tourism.

5.2.12 Industry and Mining and Water

The principal industrial activity in the Delta at the moment is salt mining in the south-west. The process involves channelling saline water into large holding ponds from which the water is evaporated leaving salt. The source of water is from the sea rather than land and the scale of current operations is not thought to have any significant impact. However, salt mining is a very intrusive process, especially when the infrastructure is first developed, and management of inflowing and wastewater can present many challenges.

5.2.13 Biodiversity and Water

The most significant impacts on biodiversity under Scenario A would result from the reduction in area of prime habitats (see Table 5.3). If conditions are examined in 2050 (36 years from now) less than 20% of forests and only a third of riverine forest would remain. Floodplain grasslands would be reduced to only half their current area and some areas of Mangrove forest would be lost.

Table 5.3 Loss of Habitat between 2010 and 2050 under Scenario A

Key Habitats	Ha (2010)	Ha (2050)	% remaining
Forest	27,100	5,000	18
Riverine forest	32,300	12,300	38
Mangrove	8,400	7,400	88
Floodplain grassland	50,800	25,300	50

Source: Tana Delta Land Use Plan, 2014

Within the Delta, loss of habitat would follow expansion of livestock grazing and subsistence agriculture and these uses would not, in themselves, directly affect the amount of water reaching the remaining floodplain habitats. However, in the absence of a positive strategy and economic case for protecting the water resources of the Delta, it is highly likely that more water would be diverted from the River Tana upstream of the Tana Delta for other uses, resulting in the continued reduction in river flows in the dry season. The combined result of reduced water flow and habitat area would result in the effective destruction of the Delta ecosystem.

5.3 Assessing Impacts on and Related to Livelihoods/Jobs

5.3.1 Introduction

In this section, the SEA explores the potential for new job or livelihood creation together with any reduction or loss of employment which might be necessitated by particular types of development. It needs to be stated at the outset that formal employment levels in the Delta are at a very low level and most people who are within the economically active age group obtain their livelihoods through subsistence farming, livestock herding, and the gathering of natural products. Less than 5% of the population receive formal payment or salaries. The LUP baseline report states that 51% of the population (52,020) constitute 'the section that can engage in meaningful productive economic activities'.

Since scenario A is based on building up the local economy by relying on traditional land use activities it can be anticipated that the growth of employment opportunities would be concentrated in subsistence farming, livestock rearing, natural resource harvesting, beekeeping and fishing. In theory, livelihoods employment could rise from its present level to 51,000 in 2030 and 93,000 in 2050 (see Table 5.4 and Figure 5.4). However, the cumulative adverse effects identified as a result of land conversion, population growth and competition between grazing and farming interests would almost certainly prevent these levels from being attained and the Tana Delta would remain as an economically depressed and poverty stricken area.

Figure 5.4 Increase in Livelihoods (Jobs) under Scenario A

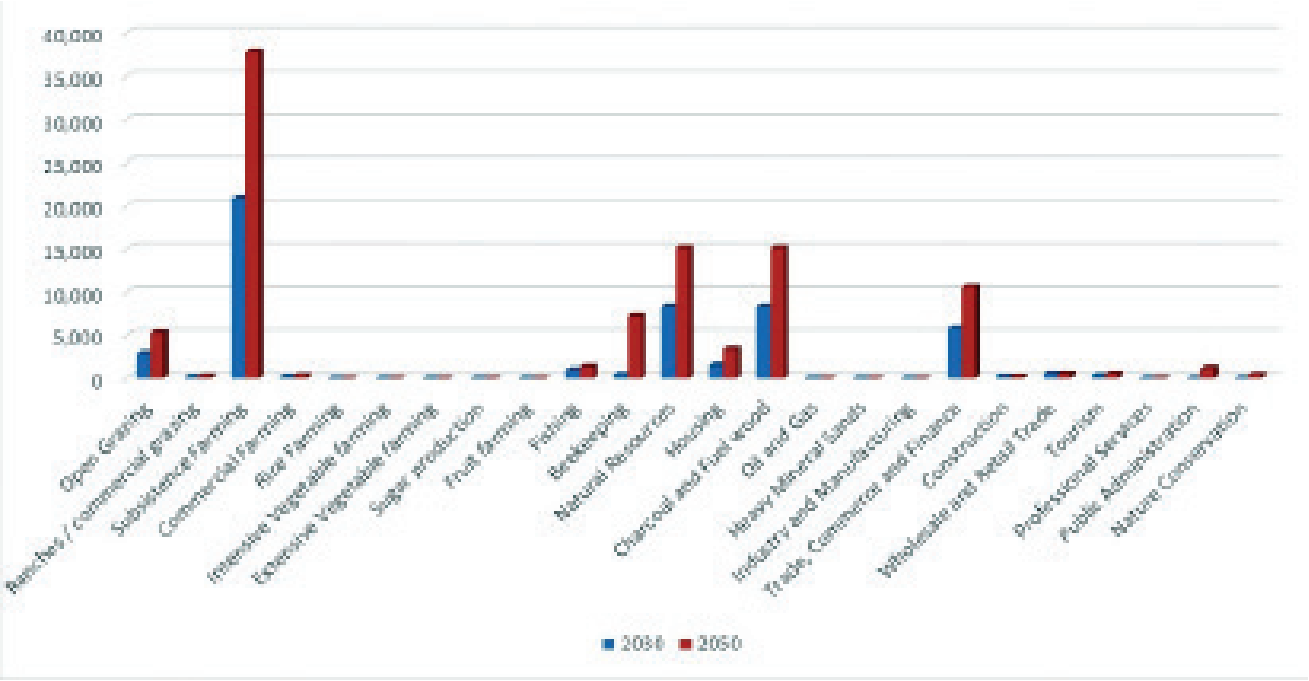


Table 5.4 Jobs/Livelihoods under Scenario A

Land Use Activities	2030	2050
Open Grazing	2,934	5,299
Ranches/Commercial Grazing	160	320
Subsistence Farming	20,913	37,861
Commercial Farming	200	400
Rice Farming	0	0
Intensive Vegetable Farming	0	0
Extensive Vegetable Farming	0	0
Sugar Production	0	0
Fruit Farming	0	0
Fishing	1,000	1,366
Beekeeping	480	7,200
Natural Resources	8,365	15,144
Housing	1,518	3,370
Charcoal and Fuel Wood	8,365	15,144
Oil and Gas	0	0
Heavy Mineral Sands	0	0
Industry and Manufacturing	0	0
Trade, Commerce and Finance	5,870	5,870
Construction	250	250
Wholesale and Retail Trade	600	600
Tourism	400	400
Professional Services	10	10
Public Administration	-	-
Nature Conservation	20	
Urban Development	0	0
Domestic Water Use	0	0
TOTALS	**51,085**	**93,254**

5.3.2 Population and Employment

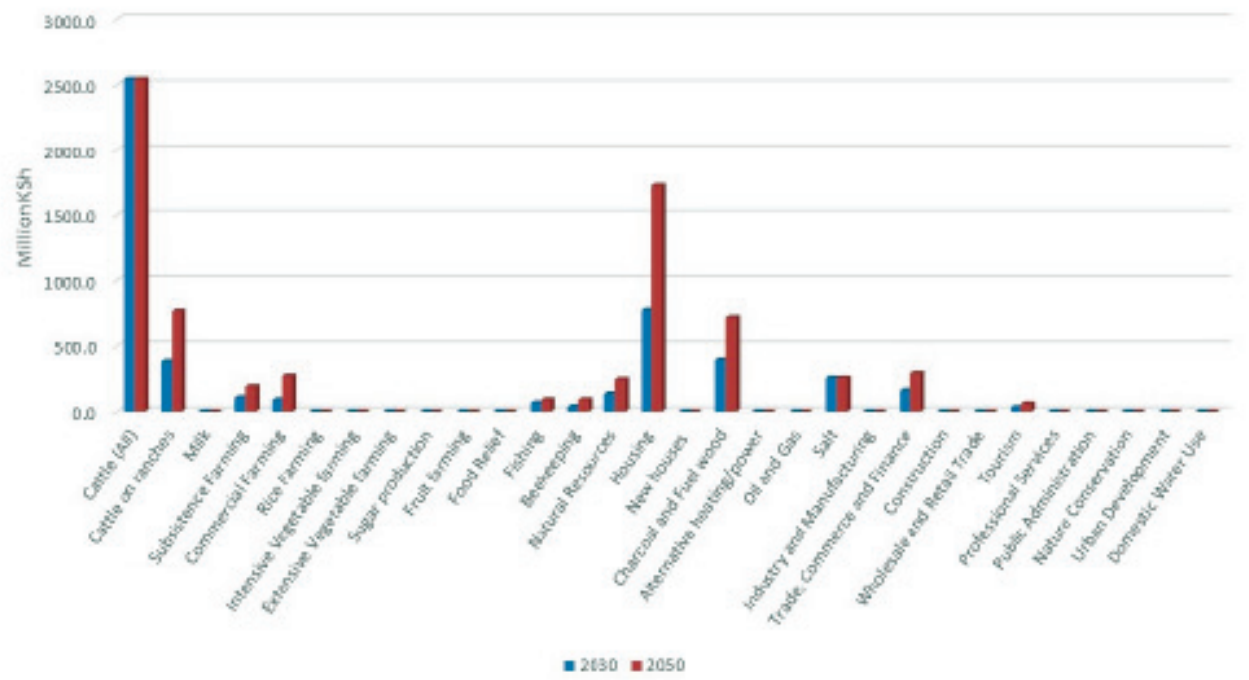
Growth of population from its present level of 102,000 to 315,000 by 2050 would give a total of 89,000 people capable of gainful employment by 2030 and 161,000 by 2050 (Odhengo *et al*, 2014b). The assumption in Scenario A has been that such employment would be derived from expansion of traditional livelihood practices, for example, harvesting building materials, producing charcoal, cultivating subsistence crops and herding animals (Odhengo et al, 2014b).

As shown above, the law of diminishing returns would apply in all of these sectors and it is apparent that the Delta could not provide the level of employment and livelihoods to maintain even existing standards of living, let alone lead to any improvement. The net consequence will be an increase in the already unacceptably high levels of poverty and all the associated issues of poor health, education, and morale.

Conclusion and recommendation: The SEA's main conclusion is that a 'business as usual' approach is not sustainable and urgent attention needs to be given to new forms of employment and livelihood.

Scenario A has been assembled by linking existing levels of employment and land use activity to rising population. In consequence it assumes that for all activities the number of jobs and livelihoods would increase on a pro-rata basis. Therefore, for example, if the number of livestock increased from 477,000 to 515,000 in 2030

Figure 5.5 Gross Value of Land Use Activities under Scenario A



and 831,000 in 2050, the equivalent rise in fulltime employment of herders would be to 2,934 and 5,299. The same situation would arise in relation to livelihoods created in subsistence farming based on 2 FTEs per household/1.5 acres.

In practice, all of the land use activities would experience increased competition between the sectors and the point would be reached at which further expansion of resource-based livelihoods became impossible. As discussed under the heading of population and land, at this stage there would be very strong pressures for outward migration as people in the economically active age groups are forced to find alternatives outside the Delta.

5.4 Value

5.4.1 Introduction

The information on the potential turnover and outputs of the different land use categories presented in Chapter 16 of the LUP has been aggregated and is presented below in Table 5.5 and Figure 5.5.

Based on the calculations underpinning Scenario A the total production under traditional livelihoods in the Delta is valued at 0.5 billion KSh and this would rise to close to 1 billion by 2030 (Odhengo *et al*, 2014b). Projecting the value of activities in the Tana Delta in Scenario A becomes increasingly difficult beyond 2030 because most of the activities would be competing for the same areas of land and it would be impractical to pursue all of them. It is clear that competing pressures will grow exponentially over the next 20 years and that the tensions which this will create if there was no resolution of priorities or agreement on the direction of future economic activity would inevitably lead to a collapse of the Tana Delta economy.

Table 5.5 Value of Different Activities (In Million Ksh.)

Activity	2010	2030	2050
Grazing	228	390	705
Farming	62	104	189
Fishing	53	65	89
Honey	19	72	180
Charcoal/Fuelwood	195	396.5	714
Natural Resources - Building Materials	130	313	695
Tourism	2.2	4.25	6.38
Total	**528**	**985**	**2,578**

Source: Tana Delta Land Use Plan, 2014

5.5 Nature Conservation and Biodiversity

5.5.1 Population Growth

Rising population would be one of the principal factors leading to a deterioration of existing habitats, increased competition for land and increased disturbance of wildlife.

5.5.2 Livestock Increase

The number of Tropical Livestock Units that can be supported within the core areas of the Delta is currently in excess of 2 per hectare but outside the wetland areas

Table 5.6 Prediction of Tropical Livestock Units in 2030 and 2050, and Equivalent Areas at Different Stocking Densities

	2011	2030	2050
TUL Equivalent for species	TLU	TLU	TLU
Cattle	211858	362227	654219
Sheep	13115	22343	40354
Goats	11868	20312	36685
Total	236841	404882	731258
Range (in Km2) needed at 1.75 TLU/ha	1,353	2,314	4,179
Range (in Km2) needed at 1 TLU/Ha	2368	4048	7313
Range needed (in Km2(At 1 TUL/ 3 Ha	7,105	12,146	21,938
Range needed (in Km2(At 1 TUL/ 5 Ha	11,842	20,244	36,563
Range needed (in Km2(At 1 TUL/7 Ha	16,579	28,342	51,188

Source: Tana Delta Land Use Plan, 2014

the stocking rate falls significantly. The current number of TLU's in the Delta is around 240,000 (see Table 5.6) and based on calculations in section 3.2.3.1 this could theoretically rise to 400,000 in 2030 and 730,000 in 2050 (Odhengo *et al*, 2014b).

Table 5.6 indicates that the current stocking densities are close to the carrying capacity of the Delta and if further increases were to occur this would only be feasible if the number of wild herbivores declined, or other habitats (i.e. woodland or permanent farming areas) were converted to grazing. To meet the projected demand for livestock, the entire Delta area would have to be converted to grazing by 2030, with dramatic impacts on biodiversity and other forms of human livelihood.

5.5.3 Farming and Nature Conservation

The issues relating to farming and nature conservation have already been reviewed in section and Table 6.1. Up to 70% of existing thicket and scrub would be cleared by 2030 and converted to dryland farming and effectively all thicket and scrub would be removed by 2050, eliminating the existing wildlife corridors. The conversion of floodplain grassland to wetland farming would cause a 20% reduction in area by 2030 and a 50% reduction by 2050. The same story would apply to the reduction of riverine forest and other forests although this would result from overgrazing and increased harvesting of non-timber forest products (Odhengo *et al*, 2014b).

Based on the projections quoted above, the biodiversity index would fall to in terms of available habitat. Wildlife would be significantly affected through reduction in feeding areas, increased completion with livestock, human-wildlife conflict and overall disturbance of the habitats.

5.5.4 Beekeeping and Nature Conservation

Beekeeping represents one of the most efficient ways of developing small businesses based entirely on harvesting a natural product. The Tana Delta is a very rich resource in terms of the extent of habitat suitable for beekeeping and the practice can be extended at low cost. There are no adverse environmental effects from promoting beekeeping providing that any plans for artificial increase in the number of stocks does not involve importing queen bees of the wrong provenance.

5.5.5 Natural Resources and Nature Conservation

Sustainable wise use should be one of the principal aims under Scenario A. If the woodlands are not managed sustainably there will be inadequate resources for the future. The descriptions in Scenario A make clear how important and valuable these resources are, providing vital ecosystem services such as building materials and food for the local communities. The analysis shows that these are very cost-effective ways of providing essential goods and services which would be much more expensive using artificial materials like zinc sheeting for roofs and concrete block work for walls instead of palm, reed and grass. However, external pressures on the natural resources and unsustainably high levels of use are more likely to occur under Scenario A in the absence of any policies for providing alternative livelihoods and employment.

5.6 Culture

From first principles, the development of Scenario A should be strongly supported by the farming, pastoral and fishing communities because it favours support for these traditional forms of livelihood. In practice, however, failure to control growth of population and inward migration to the Delta would quickly result in increasing competition between the different groups

for diminishing resources of land and water. This, in turn would make it much harder to maintain open ranching of cattle, the cultivation of flood recession agriculture and fishing in rivers, lakes and the sea.

5.7 Security

5.7.1 Introduction

The way in which the LUP and its implementation bring together the reconciliation of conflicting objectives for each area of land use activity is one of the most critical components of the LUP/SEA. It is clear that if each land use activity is pursued in isolation this will lead to increased competition and heightened tension between communities in the Tana Delta and between residents of the Delta and external interests. The issue of governance is crosscutting but this section identifies some of the issues which are particularly pertinent for each land use category in turn.

5.7.2 Population

The question of how many children a family should have is a very personal issue. If a husband and wife decide to have say seven children and are unable to feed, clothe and educate their family that is their choice, despite the fact that they have to bring up their family in abject poverty. Similarly if parents decide to limit the number of children to two or three so that they can afford to give them good food and clothing and pay for school fees that is also their choice, although for many families in the Tana Delta this is not an option.

The SEA takes the position that these are entirely matters for individuals but at the same time it stresses the importance of explaining how individual choices affect the entire community. If every household in the Tana Delta decided to have no more than 3 children, a scenario based on traditional livelihoods would look totally different from one in which the current average of 5 children is continued into the future. The present scenario shows beyond all doubt that there is no future for the Tana Delta communities, their way of life, their livelihoods, if the current average of five children per household continues.

In some societies and countries population growth rates have declined so much that the opposite concerns exist – where will the future breadwinners come from? Who will support the elderly in their old age? Clearly in the Tana Delta there is a need for a serious debate about the balance which needs to be struck between the two extremes.

Conclusion and Recommendation: The SEA advocates an approach which sees a modest increase in population without exhausting the area's natural resources. This option provides the best opportunity for giving all children a proper education, banishing poverty from the Delta and creating a promising future for all. How might this be achieved? The government has adopted clear policies on population and there are many organisations that can assist in practical measures. There should be a section in the LUP which refers specifically to the need for good advice and practical assistance in family planning.

5.7.3 Livestock

Estimates for future numbers of livestock in the Delta are based on the assumption that pastoralists will want to keep the same number, or an increased number, of cattle per household. There is already a wide variation in the numbers of cattle owned by each household with many being unable to afford more than a few animals. As a result, there has been a significant trend towards mixed farming amongst the Orma community, in which crop farming has played as big a role as livestock in supporting livelihoods. If the number of cattle per household were to decline this would have very important implications for the continuation of existing traditional practice. It would result in fewer cattle in the Delta and increased opportunities for improved grazing, better nutrition and higher live weights all of which would lead to increased value and a higher economic return.

Conclusion and Recommendation: If livestock numbers are to be managed within the sustainable carrying capacity of the Delta it will be essential to limit the number of animals that are imported from other regions during the dry season and a critical issue for the LUP will be the development of recommendations and advice on a management system and governance system for managing livestock numbers. This must include the principles of payment for grazing rights for any non-residents pastoralists and proper allocation of grazing areas to individual communities. There should also be speedy resolution of the complex land tenure issues affecting communally grazed areas where past injustices have led to land being appropriated by agencies or individuals. These are matters which should be referred to the national Land Commission and the Minister of Lands at the earliest opportunity.

5.7.4 Agriculture

Scenario A indicates that a substantial amount of land will need to be allocated for individual households use if the present minimum level of 1.5ha per household is to be provided for future households which are growing at the rate of c400 per year. At this rate the need to allocate in excess of 40 km^2 is likely to generate significant tension between existing users and the new communities. The issue is often described as a challenge between Pokomo farmers and Orma pastoralists but

the issue is increasingly blurred by the increase in mixed farming being practiced by both ethnic groups. Consequently decisions on the appropriate allocation of land for farming will affect all residents of the Delta. This issue is complicated by the fact that only certain areas are suitable for crop farming. These areas require fertile soils, good drainage, exclusion from heavy flooding, accessibility to the road network and available water in the dry seasons.

Conclusion and Recommendation: The main areas which should be considered for crop farming lie on the upper terraces or highland outside the core of the floodplain. Such areas are currently being exploited by incoming migrants who often hold different values from the traditional farming and pastoralist communities. Consequently the process of land allocation will require very sensitive management by the County Governments. The SEA recommends that a clear policy is established with transparent rules and guidance to all members of society to ensure that the past history of illegal allocation and land grabbing is eliminated.

5.7.5 Irrigation

The past history of irrigation development in the lower Tana River Basin and in the Delta in particular has seriously prejudiced attitudes towards commercial schemes but at the same time small groups of farmers and communities have shown that successful privately or communally managed irrigation can significantly enhance crop yields. The SEA considers that the question of irrigation represents one of the biggest challenges for sustainable land management within the Delta. All of the evidence points clearly to the inadvisability of seeking to develop large-scale irrigation in units over 1000ha. There is also an overriding need to assess the total demand and availability of water to support all forms of land use including irrigation. The scale of irrigation considered in Scenario A lies well within the capacity of the system but any significant increase would be likely to cause fundamental problems for the Delta.

Conclusion: Regardless of the measures that are taken to manage the scale of irrigation in the Tana Delta a more fundamental issue arises from development projects that are being considered elsewhere in the River Tana basin and in adjacent catchment areas including:

- Water diversions to Nairobi and other settlements
- Irrigation schemes
- The water required to support the LAPSSET corridor (see Chapter 4).

5.7.6 Urban and Rural Development

There is a strong international trend towards urbanisation and this is particularly pronounced on the African continent where more than 50% of the population will be living in towns and cities by 2035[8]. In the Delta a number of factors could encourage expansion of the urban areas over the next 40 years. This will include a desire to move away from areas of high flood risk and take advantage of better infrastructure and services including roads, public water supply and sanitation, and also the access to health clinics and schools. Another characteristic of urbanisation is the tendency for traditional types of housing and communal living to change from very dispersed settlement patterns to more concentrated housing layouts. In making provision for growth of urban areas it will be important to respect tradition and cultural requirements but at the same time to provide the land and facilities for new forms of development. The LUP should set out guidance on road layouts, size of housing plots and the standards of services that will be required.

5.7.7 Fishing

Communities that are heavily involved in freshwater fishing are heavily dependent on the way in which source waters are managed or mismanaged. An important governance issue is how to ensure that sufficient water is allowed to flow or is directed to existing lakes, like Moa and Bilisa. At the coast opportunities exist for enlarging the marine fisheries industry, principally by improving fish processing and marketing with better freezing facilities and transport. However, the difficult coastal conditions, including erosion of sand bars, and rough sea conditions during the monsoons, make the development of a permanent harbour a challenging task and this option has been discounted under Scenario A.

5.7.8 Natural Resources

There are a lot of significant issues relating to governance, peace and security in relation to natural resource extraction. There are still cases of illegal bush meat harvesting in the Tana Delta, including poaching of hippo and regular capture of dik-dik. Unauthorised removal of timber from protected areas also takes place.

Conclusion and Recommendation: While protected areas are managed and policed by Kenya Wildlife Service, achieving a proper balance between regulation and prohibition on the one hand and sustainable harvesting on the other is an important requirement. Scenario A shows clearly with rising population and lack of alternatives to charcoal, firewood and building material like poles, the Tana Delta's woodland resources will come under ever-increasing pressure. As part of the LUP it will be appropriate to look at alternatives to natural resources including the possibility of establishing tree plantations outside the main protected areas.

[8]http://esa.un.org/unup/pdf/WUP2011_Highlights.pdf

CHAPTER 6 Assessment of Scenario B

Introduction

Scenario B sets out a range of potential commercial development options for the Plan area. These have been assembled without considering whether they are compatible with each other, or with other objectives of the land use plan such as the wise use of resources and environmental sustainability. It is the purpose of this section of the SEA to consider how practical the individual land uses are against this wider set of objectives.

6.1 Assessing impacts on and Related to Land

The starting point for the assessment is the amount of land that each form of development requires and the implications that this has for other land uses. Figure 6.1 shows graphically those activities which have the greatest demands on land (red).

6.1.1 Population and Land

Scenario B assumes the same expansion model for population as Scenario A which allows 3% compound growth per annum. This is below the current level of 3.5% in the Tana and Lamu county areas, and may well be exceeded. Scenario B acknowledges that it would not be practical to aim to feed the increasing population by subsistence farming. Instead it explores the scope for promoting cattle ranching on a commercial scale together with communal, commercial and industrial farming and the promotion of the manufacturing and industrial sectors.

Figure 6.1 Land Demand for Different Activities

Population	
Livestock	
Agriculture	
Irrigation	
Fishing	
Beekeeping	
Natural Resource Harvesting	
Mining and Quarrying	
Manufacturing and Industry	
Construction	
Transport	
Trade, Commerce and Finance	
Wholesale and Retail	
Tourism	
Professional Services	
Public Administration	
Nature Conservation	
Urban Development	

6.1.2 Livestock and Land

Scenario B proposes that instead of allowing the size of the permanent cattle herd in the Delta to expand, with serious consequences in terms of the quality and health of the animals and unacceptable competition with other land uses (principally farming and wildlife conservation), emphasis should be placed on improving quality and value. To this end it is proposed that 250 km^2 of permanent grazing should be established and managed for fattening cattle purchased from surrounding pastoralists (Odhengo *et al*, 2014b). This permanent holding area would be formed partly within the floodplain (12,500 ha) and partly on drier terrace land (12,500 ha) which is currently covered by thicket and scrub. 20,000 cattle would be reared within the holding area each year. Remaining areas of wet grassland (383km^2) and thicket and scrub (275 km^2) would support a further 104,000 cattle on an open grazing system (Odhengo *et al*, 2014b). Reduction in the size of the permanent herd from over 200,000 to around 125,000 would require the agreement of all pastoralists and would require very extensive consultation before the proposals could be introduced.

6.1.3 Agriculture and Land

In order to accommodate the expansion in resident population an increase in the area of permanent cultivation for subsistence farming is required. Scenario B proposes that all farming households should have access to 1.5 acres (0.6 ha) for their own use. This would result in an increase in the current area of 62km^2 (2010) to 105km^2 by 2030 and 189km^2 by 2050 (Odhengo *et al*, 2014b). This expansion would need to be met by conversion of existing wet grassland in the floodplain or thicket and scrub on the terraces. In practice both categories would be affected due to the dispersed nature of the settlements in the Delta.

In addition to an expansion in the subsistence farming areas the scenario also proposes substantial increase in areas used for communal and commercial farming. A wide range of crop types is considered including intensive vegetable production, extensive vegetables, rice, sugar cane and fruit growing. Scenario B assumes a total increase of 207.5 km^2 by 2030 rising to 415 km^2 by 2050 (Odhengo *et al*, 2014b). This land would also need to be converted from existing wet grassland in the floodplain and thicket and scrub on the terraces. It could only be created at the expense of displacing grazing considered previously under Livestock – section 7.2.2 above.

The combination of subsistence farmland and communal and commercial farmland would amount to 604 km^2 by 2050, or 27% of the entire Plan area. This would approximate to the potential maximum for land suitable for cultivation (Odhengo *et al*, 2014b).

From a strategic viewpoint, the use of land for crop production for food would have precedence over meat or milk production because yields are substantially higher per hectare in terms of the numbers of people who could be fed. Both crop and meat/milk production are preferable to industrial crops in terms of the Delta's and the country's requirements for food security. Nevertheless, the scale of conversion of natural habitats envisaged under this scenario would have serious implications for nature conservation and biodiversity values as noted under section 6.6. It would also represent a significant imbalance in the allocation of resources between pastoralists and farmers.

6.1.4 Irrigation and Land

One of the main ways of raising productivity of farmland (and grazing for livestock) is to introduce water during periods of soil moisture deficits and plant stress, which occurs during the dry seasons. It has therefore been assumed that all major cropping activities and fruit production would be supported by drip feed irrigation. This constitutes a relatively low water demand by comparison with gravity fed or pivot irrigation which is practised in the case of rice and sugar cane. The implications of introducing irrigation are discussed under the section on water.

6.1.5 Fishing and Land

Scenario B introduces the ambitious plan of creating two fish farms for every one of the 106 villages in the Delta by 2050. Each farm would consist of five ponds with an average size of 500 m^2. However, despite their significance as a potential food source, the total area of all fish farms would only amount to 53 hectares (0.5km^2) or less than 0.03% of the Plan area (Odhengo et al, 2014b). Consequently, fish farming would have very little impact in terms of land demand.

Opportunities to improve access to the coastal fisheries would require a feasibility study to assess whether or not a harbour could be constructed on the tidal section of the River Tana inland from the estuary mouth and the costs and benefits of providing appropriate fishing vessels and gear for deep-water marine fishing. This study would need to consider the planned development of a dedicated fishing harbour in conjunction with the Lamu port development. In practical terms it could be difficult to justify two marine fisheries only 40km apart.

6.1.6 Beekeeping and Land

Beekeeping is another activity with considerable potential for expansion which could be achieved without requiring any significant area of land. Hives can easily be accommodated within subsistence farming land without affecting normal cropping, or in forests, scrub and thicket and other natural habitats.

6.1.7 Natural Resources and Land

In recognition of the demands likely to be made on thicket, scrub and wet grassland by livestock rearing and farming, Scenario B anticipates that expansion in natural resource harvesting would only continue until 2030. Thereafter it would be necessary for local communities to adopt modern building techniques (concrete, blocks, plaster and metal sheeting or tiles in place of grass, reeds, poles and palm leaves). In addition, a major reduction in charcoal and fuel wood would necessitate development of alternative technologies, including solar powered lighting and cooking and the use of wind energy.

6.1.8 Mining and Quarrying and Land

6.1.1.1 Mineral Sands

The development of mineral sands which are known to exist along the coastline would have very dramatic effects on the topography of the sand dunes which form an important line of coastal defence against tidal surges and storms and protect the fresh water within the Delta. It would be necessary for detailed exploration to take place before it could be said with confidence that heavy minerals were present in sufficient quantities and concentrations to justify the expense of mining. However, given the inevitable level of disturbance and adverse effects that mining would have on this core area of the Ramsar site it is highly questionable whether such exploration should be authorised in the first place.

Conclusion and Recommendation: The SEA concludes that in the light of the level of damage and interference that surface sand mining would have on the core area of the Delta, there should be the strongest presumption against authorisation of such activities.

6.1.1.2 Oil and Gas

Oil and gas extraction are also potentially disruptive and environmentally damaging but once the necessary boreholes have been drilled, wellhead caps, pumps and pipeline installations can usually be sited and aligned to avoid prime habitats. There are very important factors that need to be assessed before permission can be granted, including the need to avoid disturbance to birds and other animals from noise and temporary gas flaring and the development of plans to deal with all potential emergencies. For the reasons outlined above there can be no certainty that permits will be granted for particular operations. On the other hand, exploration should be authorised where this is likely to lead to a greater level of understanding of the potential for oil and gas extraction in Tana River and Lamu counties.

6.1.9 Manufacturing and Industry and Land

The arguments for developing new manufacturing and industrial activities that will add value to the existing natural resources of the Tana Delta in sustainable ways are strongly supported by the SEA since this is likely to be one of the most effective ways of providing employment and retaining economic value in the local economy. Suitable land exists for the development of industrial estates close to the existing main centres in the Delta and this can be released without causing significant disruption or the need to relocate existing settlements. On the other hand, construction of plant and processing works in areas remote from the existing road network should be avoided wherever possible, due to the increased costs involved, the high levels of disturbance likely to be caused to the fragile habitats of the Tana Delta and high risks of disrupting the natural hydrology of the area.

6.1.10 Construction and Land

Proposals for development will need to be assessed on their merits, and these assessments should take into consideration the construction impacts, including sources of raw materials; for example for building new roads.

6.1.11 Transport and Land

Use of roads and water for transport do not have direct effects on land, and the availability of land is not a constraint on future development.

6.1.12 Trade, Commerce and Finance and Land

These activities take place principally within urban areas and other settlements and do not raise direct issues in terms of land use. It should be noted, however, that finance for development is of crucial importance to the long term sustainability of the Tana Delta. The baseline studies for this SEA have highlighted a number of examples where national institutions and international aid partners made decisions to proceed with large scale investments within the floodplain, despite clear evidence provided by other donor aided programmes that there were severe technical, environmental, social and local economic constraints.

Conclusion and Recommendation: Any financial proposals for large scale development in the Tana Delta should be accompanied by exhaustive environmental, social and cost-benefit assessments.

6.1.13 Wholesale and Retail and Land

All wholesale and retail activities should be conducted within urban centres of the new planned industrial estates in the interests of achieving maximum efficiency in the use of land and infrastructure.

6.1.14 Tourism and Land

Relatively small areas of land are needed for establishment of leisure and tourist camps and other tourist facilities and it is unlikely that building footprints will require more than one or two square kilometres over the entire plan period. However, much larger areas need to be protected and maintained in good condition in order to create the right ambience for high income generating forms of tourism.

6.1.15 Professional Services, Public Administration and Land

This area of economic activity is linked with provision of government services, like schools, health clinics, and veterinary services. As the overall economy in the Tana Delta improves, the opportunity for strengthening all areas of public support will grow. A substantial number of new jobs will be created in the process but the land use implications form part of the expansion of urban areas where most of these jobs will be located.

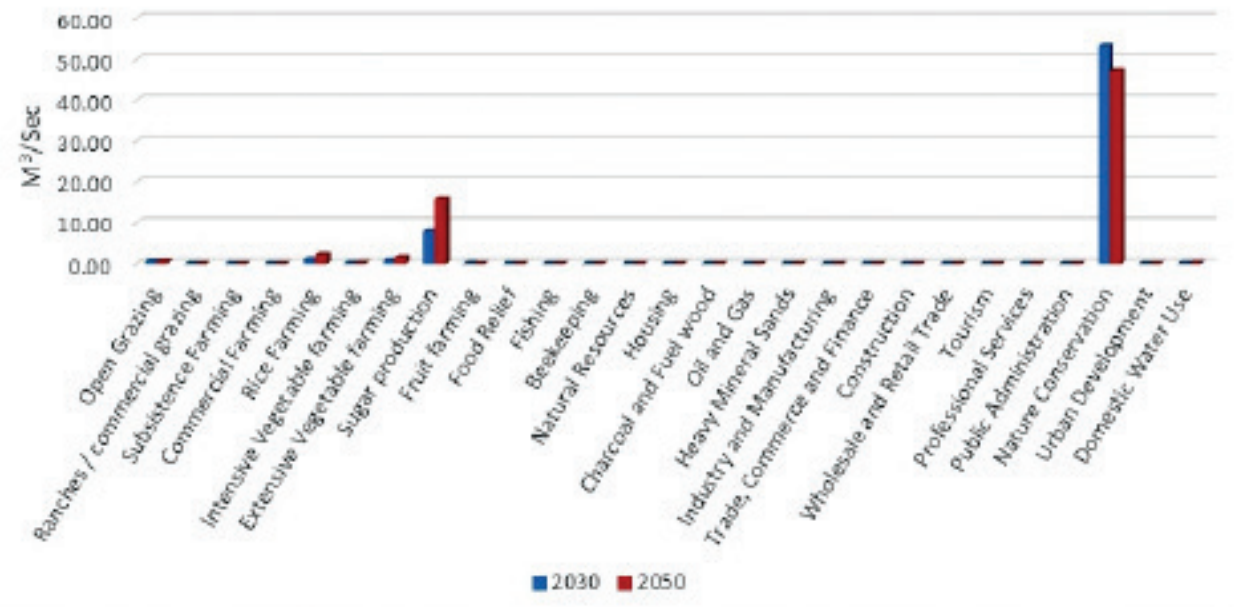
6.1.16 Biodiversity and Land

Scenario B places strong emphasis on capitalising on the economic value of nature conservation linked with eco-tourism, but in practical terms the amount of land needed for physical development is very small. Consequently the promotion of nature conservation has very little direct impact on use of land. On the other hand, conservation depends on preserving as much of the natural habitat in the Tana Delta as possible and under an intensive programme of commercial development biodiversity would come under severe pressure. Particularly damaging operations include conversion of wet grassland to farmland, and extensive irrigation of industrial crops like sugar.

6.1.17 Urban Development and Land

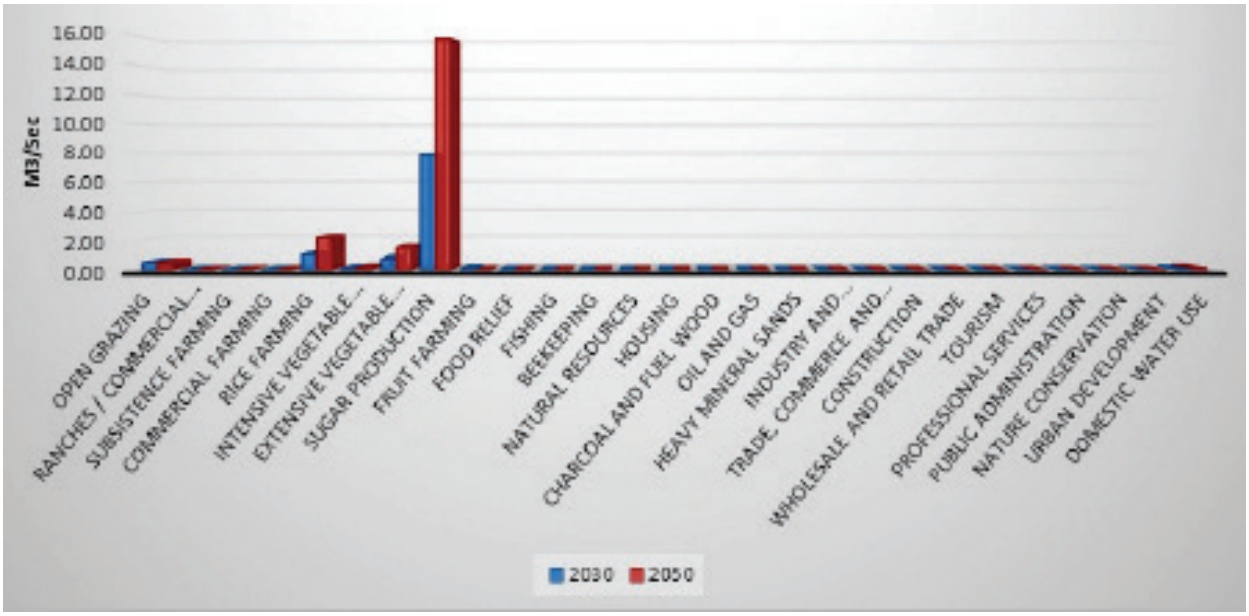
Growth of population and significant economic progress within the Delta will result in strong demand for new

Figure 6.2 Overall Water Balance following Development of Agricultural Crops in 2030 and 2050



Source: Tana Delta SEA, 2014

Figure 6.3 Relative Demand of Agricultural and Industrial Crops (Sugar Cane) in m³/sec



Source: Tana Delta SEA, 2014

housing, urban infrastructure and services and land for warehousing and factory development. Scenario B anticipates an increased demand of 676 ha for housing by 2030 and a further 839 ha by 2050. Additional land for industry amounts to 120 ha by 2050, giving a total increase of 16 km².

6.2 Impacts on and Related to Water

As discussed under the existing situation, most of the water reaching the Tana Delta enters the floodplain through channels from the River Tana and is absorbed by vegetation or transferred to the atmosphere through evapotranspiration. In order to support any of the major agricultural and irrigation developments proposed under Scenario B it would be necessary to build a balancing water storage and regulating reservoir below the High Grand Falls Dam to augment the normal flow in the river.

Table 6.1 Annual Water Demand for Crops Grown in the Tana Delta under Scenario B

Scenario B	2030		2050	
	Annual Mm^3	M3/sec	Annual Mm^3	M3/sec
Open Grazing	17.00	0.53	17.00	0.53
Ranches / commercial grazing	0.03	0.00	0.03	0.00
Subsistence Farming	0.00	0.00	0.00	0.00
Commercial Farming	0.00	0.00	0.00	0.00
Rice Farming	35.00	1.10	70.00	2.22
Intensive Vegetable farming	2.50	0.10	5.00	0.16
Extensive Vegetable farming	25.00	0.79	50.00	1.59
Sugar production	250.00	7.93	500.00	15.85
Fruit farming	3.00	0.10	6.00	0.00
Food Relief	0.00	0.00	0.00	0.00
Fishing	0.00	0.00	0.00	0.00
Beekeeping	0.00	0.00	0.00	0.00
Natural Resources	0.00	0.00	0.00	0.00
Housing	0.00	0.00	0.00	0.00
Charcoal and Fuel wood	0.00	0.00	0.00	0.00
Oil and Gas	0.00	0.00	0.00	0.00
Heavy Mineral Sands	0.00	0.00	0.00	0.00
Industry and Manufacturing	0.00	0.00	0.00	0.00
Trade, Commerce and Finance	0.00	0.00	0.00	0.00
Construction	0.00	0.00	0.00	0.00
Wholesale and Retail Trade	0.00	0.00	0.00	0.00
Tourism	0.00	0.00	0.00	0.00
Professional Services	0.00	0.00	0.00	0.00
Public Administration	0.00	0.00	0.00	0.00
Nature Conservation	1861.00	59.01	1861.00	59.01
Urban Development	0.00	0.00	0.00	0.00
Domestic Water Use	2.50	0.08	4.60	0.15
Totals	**2,196**	**69.63**	**2,514**	**79.51**

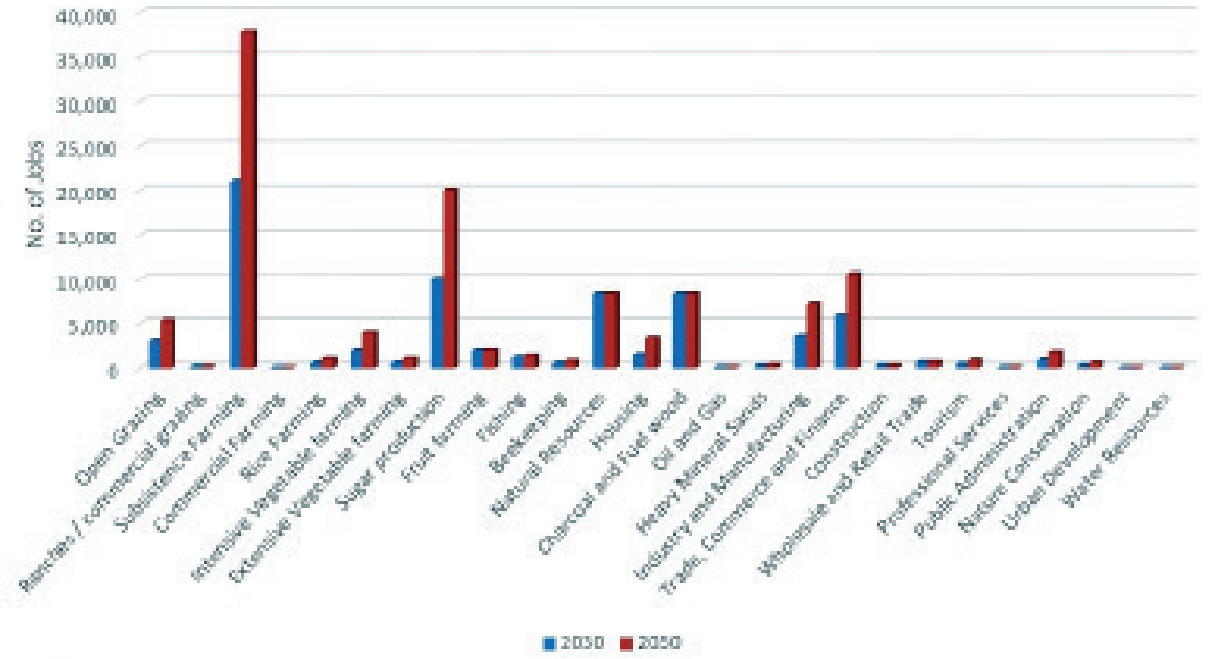
Source: Tana Delta Land Use Plan, 2014

Figures 6.2 and 6.3 show how the water balance would be affected within the Delta if the major agricultural projects were to be promoted as set out in Scenario B. The most pronounced effect would stem from creation of a 20,000 ha (200km^2) sugar plantation which would directly remove 20% of the core floodplain habitats, resulting in a reduction in water demand for nature conservation from 59.1 m^3/sec to around 47 m^3/sec through direct displacement of grassland by sugar cane. At the same time however, the overall water demand would rise by 7m^3/sec by 2050, due to the higher rates of water uptake by sugar cane compared with natural grassland (Odhengo *et al*, 2014b).

6.2.1 Sugarcane Water Requirements

Table 6.1 indicates that 10,000 ha of sugarcane would require at least 250 million m^3 of water a year by 2030, and if the area were increased to 20,000 ha by 2050 this would demand 500 million m3 a year. To put these figures in perspective, the annual flow in the Tana River – including all floods – is between 5 billion and 7 billion m3. The development of a 20,000 ha sugar plantation in the Delta (or elsewhere upstream) would therefore require between 7-10% of the entire flow in the Tana River (Odhengo *et al*, 2014b).

Figure 6.4 Number of Jobs/Livelihoods Created under Scenario B



6.2.2 Other Water Demands

By comparison with sugarcane, the next most demanding crop would be rice, with a requirement for up to 2.2m^3/sec or 70 million m^3 of water per year (Odhengo *et al*, 2014b). However, unlike sugar which is grown continuously, rice only requires substantial amounts of water when it is initially planted, much of which is provided by natural rainfall.

Other crops which have a significant water demand would include vegetable production and fruit growing. Livestock grazing and domestic consumption would also add to water demand, but the cumulative effect of all of these activities would only amount to 4.65m^3/sec or 100 million m^3/year, or one fifth of the consumption by sugarcane (Odhengo *et al*, 2014b).

6.3 Impacts on and Related to Jobs and Livelihoods

Figure 6.4 and Table 6.2 show the likely distribution of jobs and livelihoods to be created under Scenario B.

6.3.1 Agriculture

6.3.1.1 Subsistence Farming

The most significant area of job creation would arise from a policy of encouraging home production of food. If the strategy of allocating 3 acres (1.25 ha) to each farming household was adopted, this would raise the number of gainfully employed people to around 21,000 in 2030 and 37,000 in 2050 representing 24% of the 'economically active' class in these two timescales and 30-33% of all jobs created within the Delta (Odhengo *et al*, 2014b).

6.4.1.2 Sugar Production

The second largest category of new jobs would be provided by a sugarcane plantation and factory. Provisional estimates suggest that one full time equivalent (FTE) job would be created from each hectare of cane, indicating a labour force of 10,000 could be required by 2030, rising to 20,000 in 2050. In addition, substantial employment would be generated in the processing factory (800 jobs) and in transport of raw cane and processed sugar (around 500 jobs) (Odhengo *et al*, 2014b).

The promise of work and regular wages and other potential benefits as part of an overall employment package could be very attractive to some residents within an area like the Delta which has virtually no formal employment and high levels of poverty. However, these benefits would need to be balanced against the loss of livelihoods and forced relocation of local communities, with an estimated 25,000-30,000 people requiring to be resettled in order to clear the land for sugar production (Odhengo *et al*, 2014b).

Table 6.2 Distribution of Livelihoods under Scenario B (FTE)

Land Use Activity	2030	2050
Open Grazing	2,934	5,299
Ranches / commercial grazing	100	100
Subsistence Farming	20,913	37,861
Commercial Farming	0	0
Rice Farming	500	1,000
Intensive Vegetable farming	2,000	4,000
Extensive Vegetable farming	500	1,000
Sugar production	10,000	20,000
Fruit farming	2,000	2,000
Fishing	1,200	1,400
Beekeeping	480	720
Natural Resources	8,365	8,365
Housing	1,518	3,370
Charcoal and Fuel wood	8,365	8,365
Oil and Gas	50	50
Heavy Mineral Sands	200	300
Industry and Manufacturing	3,600	7,200
Trade, Commerce and Finance	5,870	10,628
Construction	250	250
Wholesale and Retail Trade	600	600
Tourism	400	800
Professional Services	20	40
Public Administration	850	1,800
Nature Conservation	250	500
Urban Development	0	0
Water Resources	0	0
Totals	70,965	115,648

Source: Tana Delta Land Use Plan, 2014

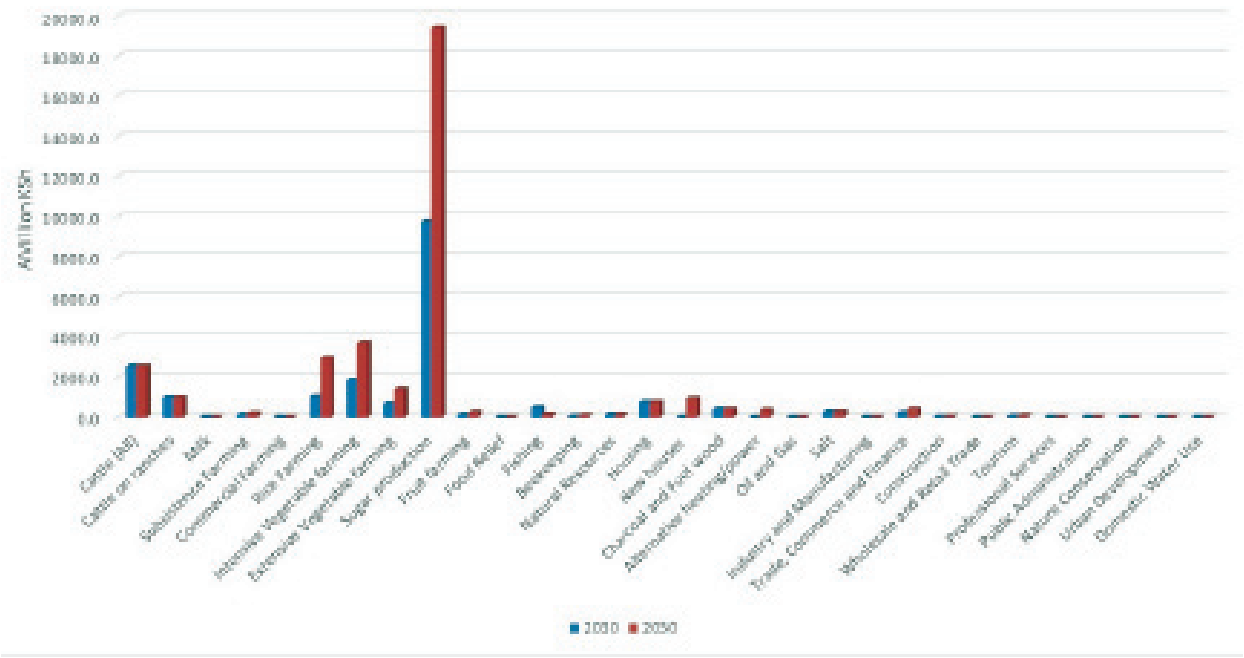
6.4.1.3 Intensive Vegetable and Fruit Production

The Delta also offers excellent potential for raising vegetables and fruit commercially, with two or three growing seasons a year for vegetable crops. Employment in both these sectors is high -four times greater, at 4 FTEs per hectare, than sugar, rice or other extensive crops (Odhengo *et al*, 2014b). In the models chosen under Scenario B only relatively small areas of land have been allocated to these land uses, given the amount of land required to establish sugar cane production. However, the options are explored later in Scenario C of developing vegetables and fruit as alternatives to sugar cane.

6.3.2 Beekeeping, Fish Rearing and Natural Resource Harvesting, including Charcoal and Fuel Wood

These activities have been grouped together since they all depend on utilising the existing resources of the Delta. Around 20,000 livelihoods would continue to be supported by these traditional activities in 2030, and up to 23,000 livelihoods in 2050, although loss of natural habitat as a result of agricultural expansion would severely restrict growth in these sectors beyond 2030 (Odhengo *et al*, 2014b).

Figure 6.5 Gross Value of Land Use Activities under Scenario B (Including Sugar)



6.3.3 Summary

The total number of jobs created in 2030 under Scenario B would be in the region of 71,000, although 5,000 existing livelihoods would be displaced, by conversion of wet grassland to sugar cane. By 2050, up to 116,000 jobs could be created - with displacement of around 10,000 livelihoods (Odhengo *et al*, 2014b).

6.4 Value

Figure 6.5 shows the range of land use activities with a measure of their repespective economic value. It should be noted that the basis on which 'value' is calculated varies with the different commodities and so a direct comparison is not possible. For example, the value of livestock represents the gross value of all stock, including animals that are kept within the herd and are neither purchased or sold. Estimates of crop value are based on annual sales, while sugar is assessed in terms of the price of sugar per tonne after processing, rather than the value of the standing crop. Nevertheless the relative figures of these commodities are indicative of overall economic value.

6.4.1 Agriculture

6.4.1.1 Sugar Production

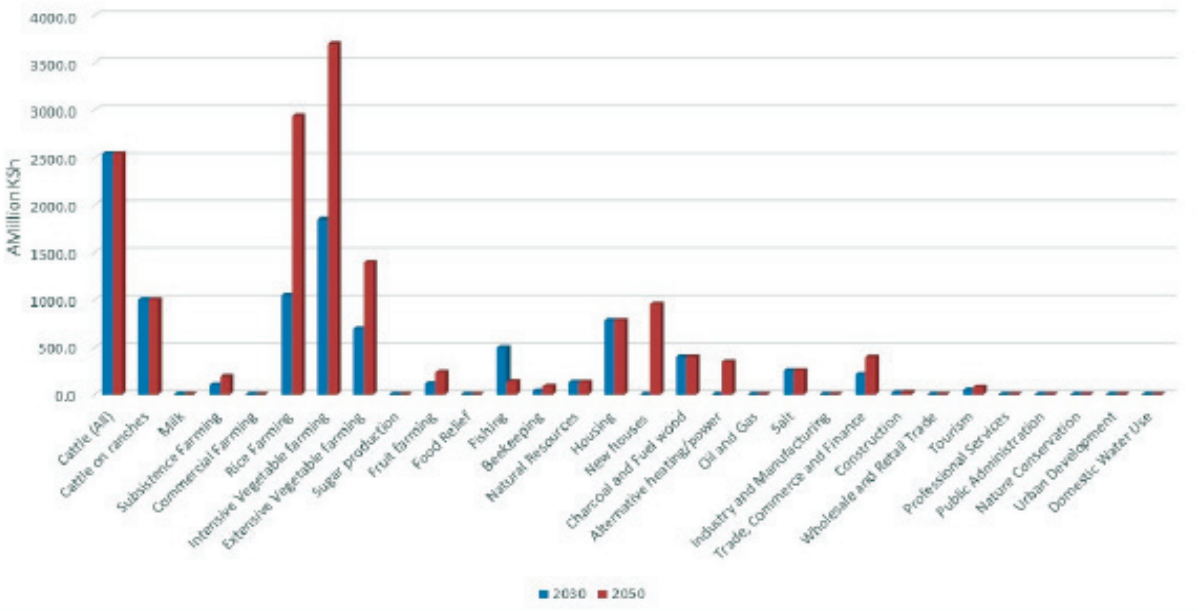
Sugar has potentially the highest value of all crops that could be produced in the Delta. Its value is based as much on its industrial as its nutritional uses. As a globally traded commodity, price is heavily influenced by international trading agreements and most of the financial benefit in production would be transferred outside the Delta, apart from wages and payments for local services. The potential value of sugar to the local community would be increased if a higher proportion of the total crop were to be produced by contract farmers but this is generally a less efficient and therefore more costly way of providing the raw material.

Assessment of overall economic value for any given commodity needs to be based on more than the price and return on investment to individual companies and shareholders. It also needs to reflect the sum of benefits provided to the region in which production takes place and delivery of government priorities. As a food source, sugar has a lower nutritional value in the fight against poverty and malnutrition than other staple crops like rice, maize and vegetables.

6.4.1.2 Other Crops

If sugar is excluded from the list of crops considered under Scenario B, as shown in Figure 7.6, rice and vegetable growing both appear to offer considerable potential for creating good economic returns in the Tana Delta, although the areas allocated to these crops in Scenario B were not optimised. While sugar is shown as providing 10 billion KSh in 2030, the combined value of rice and vegetables would be 3.6 billion KSh. The equivalent figures for 2050 would be 19.5 billion KSh for sugar and 8 billion KSh for vegetables and rice (Odhengo *et al*, 2014b).

Figure 6.6 Gross Value of Land Use Activities under Scenario B (Excluding Sugar)



Source: Tana Delta Land Use Plan, 2014

6.4.2 Livestock

As previously noted, the overall value of livestock in the Tana Delta exceeds 2 billion KSh, although this figure is substantially higher than the value of stock traded in the marketplace each year. Nevertheless if a commercial cattle rearing scheme were introduced along the lines of the model proposed in Scenario B the sale of up to 20,000 prime animals a year could generate 0.3 billion KSh (Odhengo *et al*, 2014b).

6.4.3 Other Land Use Activities

Other land use activities making a valuable contribution to the local economy under Scenario B by 2050 would include salt production (250 million KSh), fishing (89 million KSh), house building (1,730 million KSh), trade and commerce (288 million KSh), natural resource harvesting (including charcoal and fuelwood)(956 million KSh), beekeeping (90 million KSh) and tourism (60 million KSh) (Odhengo *et al*, 2014b).

6.5 Impacts on and Related to Nature and Biodiversity

Scenario B highlights the opportunities for developing eco-tourism based on the natural resources of the Tana Delta. These include developing trails and boardwalks in key forest habitats, creating a water-based trail through the wetlands and establishing a number of eco-lodges. However, the primary objective behind establishment of the Tana Delta as a Ramsar Site is to ensure conservation and sustainable use of its outstanding ecosystem which is important for international conservation of wildlife and particularly migratory birds.

A number of the proposed land use activities outlined in Scenario B are compatible with these conservation and sustainable use objectives. The area of the Tana Delta is large enough to accommodate resident communities, traditional livelihoods, agriculture, tourism, fishing and other forms of sustainable development. By adopting a tiered approach with an outer buffer zone, commercial and industrial areas around major settlements, and an inner core where nature conservation and compatible uses predominate, the Delta is capable of meeting a wide range of different needs, including a contribution to national food security. There are however, certain uses and activities that are not compatible with the overriding objectives of the Constitution, Ramsar designation, or the Government's policies for water conservation, wetland conservation, wildlife protection and protected areas. These uses include:

- Extensive surface mining which would destroy surface habitats,
- Industrial crop production which would demand large volumes of water and destroy surface habitats,
- Any land use which would displace existing communities and require major resettlement, due to the indirect impacts that this would have on nature conservation interests.

Conclusion and Recommendations: From the analysis of the development options considered under Scenario B it is clear that large scale heavy mineral extraction would run counter the primary policies and objectives for conservation of the Delta and this option should be excluded from the Land Use Plan and future land use strategy.

It is also clear that the conversion of large areas of natural habitat, including wet grassland in the floodplain for industrial cropping of sugarcane, would be extremely damaging to the hydrology, ecology and livelihoods in the core area of the Delta.

Although sugarcane production has been considered in the past, circumstances have radically altered since plans were initially drawn up in the 1980's. These changes have been particularly marked in the last five years since an incomplete Environmental Impact Assessment was submitted which is no longer valid. The changes which have taken place include:

- Radical realignment of the main channel of the Tana River through the lower floodplain, which alters the assumptions on which earlier plans were based,
- Greater knowledge about the hydrological regime of the River Tana and the need to conserve water throughout the River Tana basin,
- Increased scientific knowledge on the rarity of individual species of animals and plants in the Tana Delta,
- Substantial increase in the local population and the numbers of people who would be affected by development,
- Formal acknowledgement by the Courts of the legal rights of local communities and of the need for all plans to be subject to detailed consultation amongst the communities prior to approval,
- The development of alternative livelihood and development strategies which offer better returns, economically, socially and environmentally than the former out-dated plan.

6.6 Culture

The Constitution celebrates Kenya's cultural diversity and affirms the rights of all people to live their own lives. It also emphasises the responsibilities that individuals, communities and the government have to protect these values. In the Tana Delta many traditional values and livelihoods are still maintained by farmers, pastoralists and fishers but these special qualities are under pressure from competition for scarce land, water and natural resources.

The SEA shows very starkly that major changes will occur within the Tana Delta over the next 36 years as a result of both internal and external forces. Some of these changes will require a special effort from the communities themselves to adapt to new livelihoods and lifestyles.

Conclusion and Recommendation: One of the most important challenges is for both pastoralists and farmers to agree on a strategy for sharing the finite resources of the Delta and the analysis of Scenario B points to the need to limit both the amount of land which is converted from wet grassland to agriculture and the size of the cattle herds (and other livestock) that graze within the Delta. These issues are addressed in more detail under Scenario C, which seeks to strike a balance between a strategy based on traditional livelihoods set out in Scenario A and the commercially-oriented approach set out in this Scenario.

6.7 Security

In recent years, long-standing tensions between different sectors of the communities in the Tana Delta have led to clashes and it cannot be a coincidence that the worst abuses have occurred around the time of national and local elections. However, the underlying causes of resource competition remain and in future, the risk of conflict will grow unless there is a better understanding of the ways in which communities can live and work together for the common good.

Unfortunately, previous administrations, government agencies and private companies have sometimes ignored the rights of communities. Many families in the Tana Delta experienced the trauma of being forced out of their traditional homes in order to make way for irrigation projects designed in the 1960's, 70's and 80's that subsequently failed. This recent history has created a legacy of anti-government sentiments which runs deep in local consciousness. The community representatives attending meetings of the Tana Planning Advisory Committee (TPAC) as part of the LUP /SEA process, and numerous villagers participating in village consultations have stated in unequivocal terms that they will fight for their rights to decide their own futures.

Conclusion: The process of planning is not something that can be imposed on unwilling participants, and the success of the land use strategy, policy statements and regulations which are recommended through the LUP and this SEA will depend largely on the support that is given to them by everyone who lives and works within the Tana Delta.

CHAPTER 7 Assessment of Scenario C

Introduction

Scenario C is already a product of the SEA since it draws together those activities and elements which are most likely to offer a long term sustainable future for the Tana Delta. The Scenario starts with an important section on the process of developing a land use strategy in which four options are discussed. These are:

- *Business as usual*
- *Self-sufficiency*
- *Community-led enterprise, and*
- *Public/private partnerships*

The arguments against 'business as usual' are clearly stated in Volume 2 of the Tana Delta land use plan from which the following quotation is taken. Business as usual represents 'continued appropriation of land which is technically in public ownership as individual developers seek ways of promoting their own vested interests....leaving existing users angry and frustrated and leading to greater insecurity, tensions and conflict' (Odhengo et al, 2014b).

Unfortunately, some national and international companies and agencies still regard themselves as having a freedom to operate above the law and it will require the adoption of the Tana Delta land use plan by the two county governments and the Ministry of Lands on behalf of the National Government to ensure that order is finally brought to decision-making processes in the Delta.

The SEA supports the conclusions drawn in the Tana Delta land use plan (LUP) that future development should be based on a combination of self-sufficiency, community-led enterprise and public/private partnership but it also stresses the need for bold leadership by the County Governments to ensure that the right mix is achieved. If the natural resources and outstanding environment of the Tana Delta are to be preserved for the future it is imperative that ways are found of creating new jobs and livelihoods in sustainable economic activities. These should include radical changes in the management of livestock within the Tana Delta and surrounding areas and the promotion of community based farming enterprises, supported by carefully selected private partners.

7.1 Impacts on and Related to Land

The basic concept of allocating 650 km^2 of land for livestock grazing and a similar amount (650 km^2) to permanent agricultural production is supported by the SEA, subject to a caveat that detailed surveys should be undertaken to establish exactly which areas of land are suitable for the two primary purposes. For example, simply drawing a line on a map between two villages will not resolve complex questions of land rights or ensure that the soils and hydrology are suitable for the proposed end use.

Research undertaken for the SEA and LUP as part of the detailed village survey proved how difficult it is to define physical limits without: a) full engagement of community leaders and b) detailed recording of locations using a global positioning system (GPS).

The task of producing accurate maps of all parts of the Delta at a scale suitable for determining detailed land uses (i.e. not larger than 1:50,000) is likely to take two years, assuming that the necessary funding is in place.

The mapping process also needs to include preparation of an accurate digital terrain model to replace the hand-generated model created in the course of the SEA. This model needs to record ground levels to an accuracy of +/-0.5 metres, so that land and water management can be developed in parallel. The SEA has highlighted findings from other international studies which confirm that parts of the lower delta are vulnerable to sea level rise over the next 50-100 years and better knowledge of the potentially affected areas will be important.

7.1.1 Livestock and Land

7.1.1.1 Open Grazing

The concept of managing the number of cattle that are allowed to graze in the Plan area, by registering their owners and obtaining an annual statement of the numbers each individual intends to keep within the Delta, is easy to set out on paper but would be impractical on the ground without the full agreement and cooperation of owners. Nevertheless, government veterinary services are fully familiar with the need to monitor livestock movements and to guard against the spread of transmissible diseases so the first critical step will be to get the agreement of all owners to the principles.

7.1.1.2 Commercial Grazing

Reduction in the numbers of cattle grazed in the core area of the Delta is in the long term interest of all pastoralists, as well as achieving overall benefits for other land uses including farming, tourism and nature conservation. Precisely how this is done, however, is likely to be a matter of considerable debate. The commercial model set out in Scenario B in Volume 2 of the LUP could provide a very effective way of controlling cattle numbers, improving quality of stock and providing higher levels of income. This would, however, necessitate agreement on the areas chosen as fattening and holding areas, the establishment of an overall management structure which would be run in a totally honest and transparent manner and the creation of the necessary infrastructure including a state-of-the-art abattoir, cold stores, refrigerated transporter trucks and marketing agreements in major cities. The development of a commercial undertaking of this nature would require both the local knowledge and expertise of cattle breeders in the Delta and the specialist business skills of commercial business entrepreneurs.

7.1.2 Agriculture and Land

A key objective under Scenario C is to allocate sufficient land for households to become self-sufficient. However, continued growth of population will make it difficult if not impossible to provide every household with 3 acres (1.25 ha) and the point will be reached where it would be preferable to create larger communal farming enterprises which can be managed more efficiently and economically and can generate a surplus of food for sale. These issues are discussed in detail under section 5.8.1 in Volume 2 (Scenario C) of the Land Use Plan. The assumption has been made that the maximum allocation of land that should be contemplated for subsistence agriculture would be 25,000 ha.

Communal and commercial farming is proposed on 3000 ha (for rice) which equates with the area developed by TARDA to the west of the Gamba settlement. This area should be handed back to local farming enterprises, with TARDA providing a service role in provision of water supplies, machinery and farm inputs, rather than as manager of a state enterprise.

A major initiative under Scenario C would be the creation of up to 80 communal farms, each covering 50 ha (4000 ha in total), to be managed along commercial lines to produce food for local consumption and for 'export' to markets in Mombasa and Nairobi.

7.1.3 Nature Conservation, Tourism and Land

The third dominant land use, in addition to livestock and agriculture, would be a range of activities based on utilising natural resources of the Tana Delta including its biodiversity and tourism potential. A core area of habitats including riverine forest, forests in general, mangrove, and wet grassland in the floodplain would continue to service a wide range of functions, including materials for house building, food, medicinal plants, honey and livestock grazing. In addition, establishment of nature conservancies to support tourism and strengthen communities would become important income-generating sources of new employment.

7.1.4 Fisheries and Land

The development of freshwater fisheries, envisaged in Scenario B, would be continued and extended under Scenario C since this is a benign use of land which can provide significant income as well as an important source of food and protein.

7.1.5 Urban Development and Land

An important component of the land use plan and strategy for the Tana Delta should be the preparation of separate community development plans for each of the recognised settlements. The standpoint of the SEA is that this represents a significant challenge, because some settlements have been established within the last thirty years in locations chosen because they were thought to be free from the risk of flooding, or were in isolated and remote locations where conflict with other land users would be reduced. These are all very logical reasons, but unfortunately it is very difficult to provide isolated settlements with roads, electricity and sanitation, and the small number of residents seldom justifies the costs of setting up schools, clinics and other public services.

Conclusion and recommendation: The SEA strongly recommends that a hierarchy of settlements is approved under the LUP where priority will be given to provision of public services. These settlements should include as the first tier:

- Garsen
- Witu
- Tarasaa
- Kipini

A secondary tier of settlements should be identified based on detailed surveys undertaken in the next 2-3 years. In developing the list of settlements to be earmarked for future development, careful consideration should be given to the following criteria:

- Is there sufficient adjacent land to allow for expansion of economic land uses including commercial farming?
- Is the settlement located in an area which is safe from regular flooding?
- Is the settlement easily accessible from main roads and services?

- Is the settlement and its surroundings exposed to long-term risks in terms of climate change and sea level rise?

7.1.6 Summary

The land use changes envisaged under scenario C would lead to a 15% reduction in the extent of habitats that currently provide important nature conservation value, but this loss would be compensated for by greater emphasis on the development and sustainable management of the core ecosystem within the floodplain, forests, mangroves, and coastal dune systems. The balance struck between areas in agricultural use, in use for livestock grazing and for wider use of all communities, including sustainable development of natural resources and protection of biodiversity, represents the best option for minimising conflict over alternative land uses.

7.2 Impacts on and Relating to Water

Figure 7.1 demonstrates very clearly that Scenario C maintains the current emphasis on the need to protect the water resources of the Tana Delta by maintaining an ecological or 'environmental reserve' of 60 m^3/second in the flow of the River Tana. All other proposed water uses are insignificant when compared with this primary objective.

If maintenance of the ecological/environmental reserve is accepted as being of the highest priority and is excluded from the equations on water balance it is possible to represent the additional water demands of the different land uses, as shown in Figure 7.2.

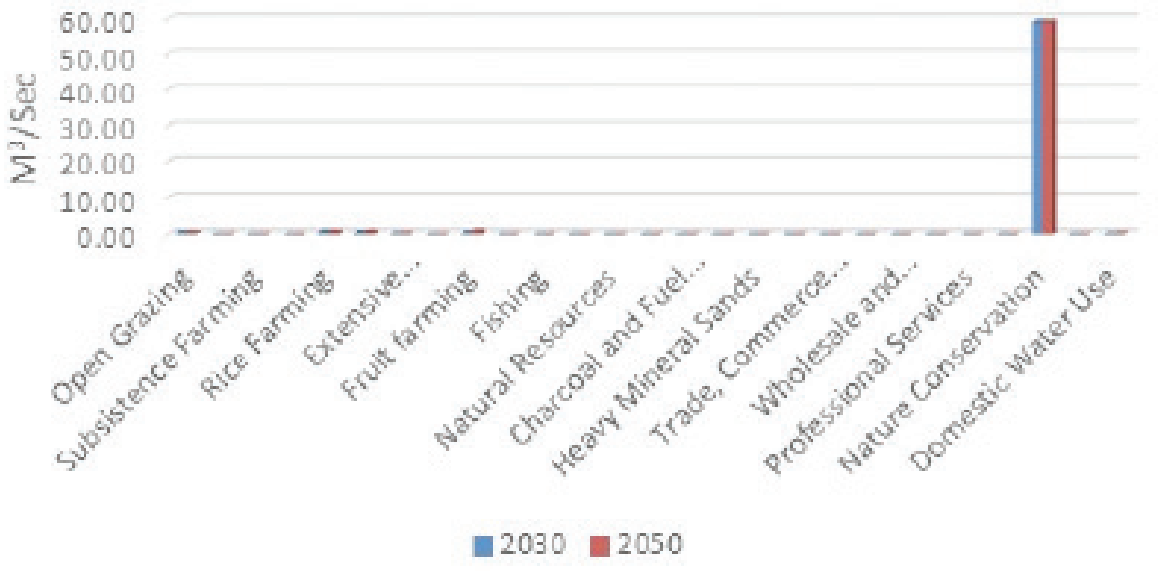
Detailed analysis in Table 7.1 shows that each of the activities produces a requirement for less than 1m3/sec, with the highest demands being for fruit farming (0.7 m^3/sec), Rice cultivation (0.68 m^3/sec) and intensive vegetable cultivation at 0.6 m^3/sec. Taking all areas of future water demand to 2050, the cumulative daily requirement would be for 61.84 m^3/sec, including the environmental reserve of 59.01 m^3/sec. The overall increase in demand would therefore represent 2.83 m^3/sec in 2050 (Odhengo *et al*, 2014b). This compares with a projected 0.62m3/sec increase under Scenario A and 19.51 m^3/sec increase under Scenario B.

7.2.1 Irrigation

Many millions of dollars have been spent over the last forty years in trying to level large parts of the Tana Delta with earth moving equipment, introduce irrigation and manage commercial rice production without success. The shortcomings of all these schemes have included the fact that they were largely designed and implemented by external agencies in the face of strong opposition from the local communities.

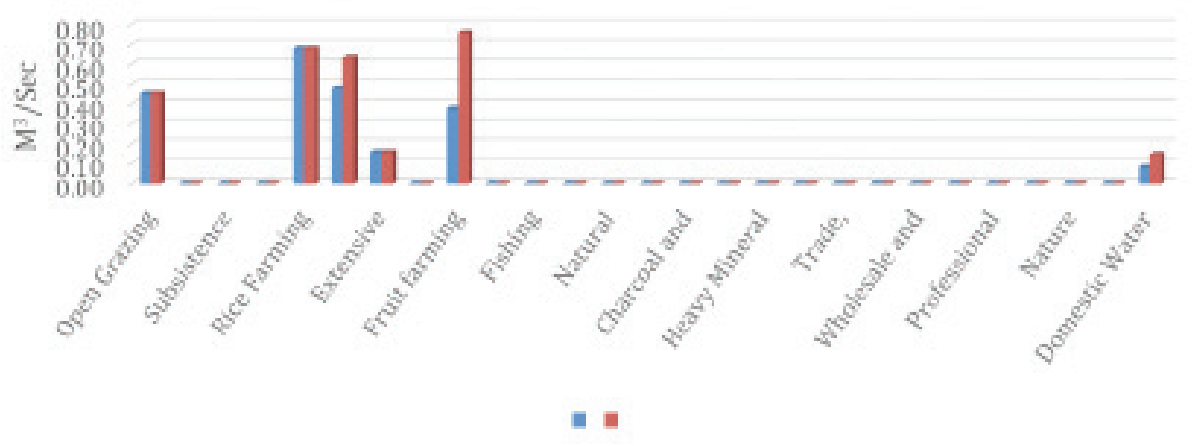
For future irrigation schemes to succeed the first requirement would be for these to be owned and

Figure 7.1 Maintenance of the Environmental Reserve Dominates Water Demand under Scenario C



Source: Tana Delta Land Use Plan, 2014

Figure 7.2 Water Demand under Scenario C Excluding the Environmental Reserve



Source: Tana Delta Land Use Plan, 2014

promoted by the communities themselves in partnership, where appropriate, with relevant business and technical experts.

A key issue for all irrigation schemes is the need to determine a reliable source of water. Attempts to divert the River Tana and provide weirs and sluices have often failed because the river has subsequently adopted a new meander pattern after flooding. The consultant engineers working on the Feasibility Study for the High Grand Falls Dam have stressed the constraints involved in trying to construct new irrigation schemes within the Lower Tana Delta, other than refurbishing the existing Integrated Rice Project (Odhengo *et al*, 2012c).

One option that is being widely explored in the Middle Tana Basin is to divert part of the river flow into canals or pipelines from a barrage constructed upstream of Garissa and then to channel this water onto relatively flat plateaus of land lying outside the Tana River catchment. Unfortunately, these options would all result in the permanent diversion of water away from the Tana, with disastrous consequences for water users in the sections of the Tana basin from Hola to the sea.

If large scale irrigation schemes are to be developed using water from the River Tana a fundamental principle should be that the diverted water is returned after use to the main channel. There is scope for additional irrigation to be provided in the upper section of the Tana Delta between the Primate Reserve and the Garsen-Witu road, and there are also opportunities for creating smaller irrigation schemes in the lower Tana Delta using pumps to abstract water from the river. Before these schemes can be developed, however, it is essential that the necessary storage reservoir is built below the High Grand Falls Dam, and full hydrological studies are conducted in the Upper and Lower Delta.

7.3 Impacts on and Related to Jobs and livelihoods

The largest number of employment opportunities to be created under Scenario C lie in increased self-sufficiency for individual farmers. If the amount of land indicated in section 8.2 (up to a total of 25,000 ha by 2050) is allocated to individual farmers this would provide the equivalent of 60,000 full time jobs. This approach is required in order to meet the anticipated continued rise in population, without which malnutrition and severe food shortages will increase. However, the type of employment is limited to subsistence farming which involves heavy manual labour and would do little to adjust the gender imbalance since most farming activity is carried out by women.

The solution to providing higher employment must lie in adding value to local produce through processing, manufacturing and trading and every effort should be focused on creating marketing cooperatives for packaging and transporting foodstuffs to major national markets. These ideas are incorporated in Scenario C by developing four industrial sites and promoting factory development for fruit, vegetable and meat processing. Figure 7.3 reveals that up to 10,000 jobs could be created by 2030 and 16,000 jobs by 2050 in trade, commerce, finance, industry and manufacturing. A further 15,000 jobs would be created in communal and commercial farming by 2030, rising to over 26,000 jobs by 2050 (Odhengo et al, 2014b). These predictions of increased employment in specialised farming and fruit growing

Table 7.1 Water Demand of Different Activities

Scenario C	2030		2,050	
	Annual Mm^3	M3/sec	Annual Mm^3	M3/sec
Open Grazing	14	0.45	14	0.45
Ranches / commercial grazing	0	0.00	0.03	0.00
Subsistence Farming	0	0.00	0.00	0.00
Commercial Farming	0	0.00	0.00	0.00
Rice Farming	21.5	0.68	21.50	0.68
Intensive Vegetable farming	15	0.48	20.00	0.63
Extensive Vegetable farming	5	0.16	5.00	0.16
Sugar production	0	0.00	0.00	0.00
Fruit farming	12	0.38	24.00	0.76
Food Relief	0	0.00	0.00	0.00
Fishing	0	0.00	0.00	0.00
Beekeeping	0	0.00	0.00	0.00
Natural Resources	0	0.00	0.00	0.00
Housing	0	0.00	0.00	0.00
Charcoal and Fuel wood	0	0.00	0.00	0.00
Oil and Gas	0	0.00	0.00	0.00
Heavy Mineral Sands	0	0.00	0.00	0.00
Industry and Manufacturing	0	0.00	0.00	0.00
Trade, Commerce and Finance	0	0.00	0.00	0.00
Construction	0	0.00	0.00	0.00
Wholesale and Retail Trade	0	0.00	0.00	0.00
Tourism	0	0.00	0.00	0.00
Professional Services	0	0.00	0.00	0.00
Public Administration	0	0.00	0.00	0.00
Nature Conservation	1861	59.01	1861	59.01
Urban Development	0	0.00	0	0.00
Domestic Water Use	2.50	0.08	4.60	0.15
Totals	1,931	61.24	1,950	61.84

Source: Tana Delta Land Use Plan, 2014

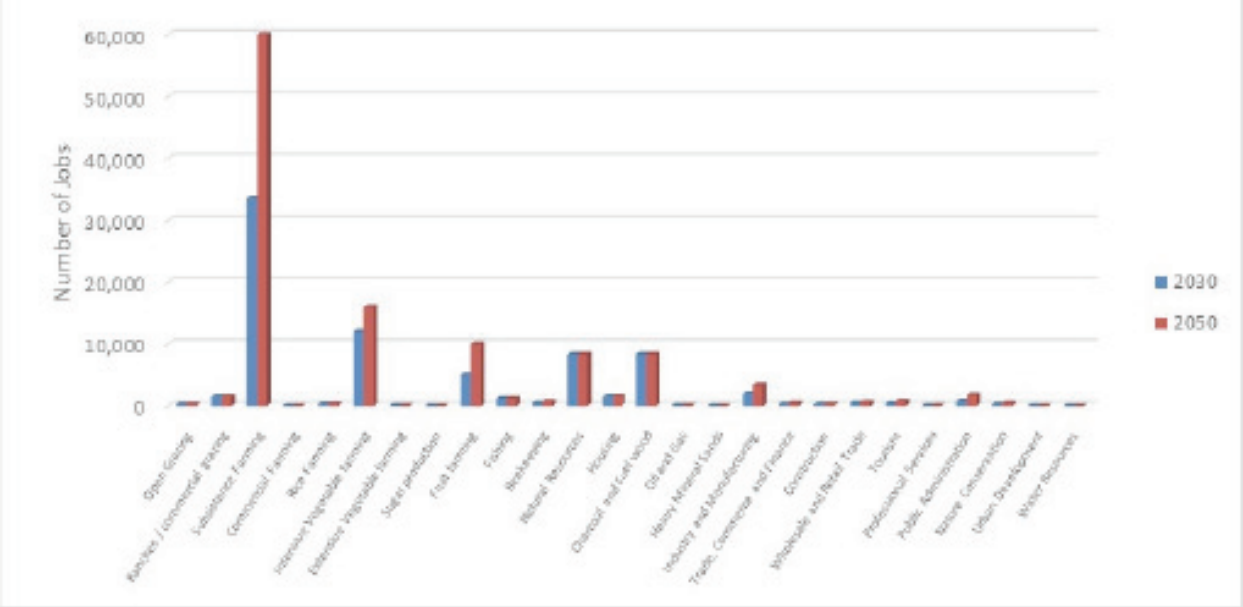
are highly significant because the number of jobs would more than match those created in a local sugar industry. Furthermore, jobs in vegetable and fruit farming would provide greater opportunity for local skills development and the creation of individual business enterprises than reliance on a monoculture crop under centralised management.

Table 7.2 shows that taken across all economic sectors the number of jobs created under Scenario C would exceed those provided by Scenarios A and B with 85,000 FTEs created by 2030 and 130,000 FTEs by 2050. The current population forecast of 315,000 people in the Delta by 2050 is unacceptably high in terms of the demands this would make on land and water resources, but a population of 250,000 could be supported by the number of jobs created under Scenario C with full employment for all economically active members of the community.

7.4 Impacts on and Related to Value

Table 7.3 shows the value of different activities. The assessment of alternative crops undertaken as part of Scenario B reveals that vegetable production could be one of the main economic activities in the Tana

Figure 7.3 Job Creation under Scenario C by 2030 and 2050



Source: Tana Delta Land Use Plan, 2014

Delta, providing that the necessary transportation and marketing facilities are developed in tandem with food production. The range of crops that can be grown in the Delta is very wide and this, combined with opportunities for growing three crops a year, provides major opportunities. Some enterprising farmers from both the Pokomo and Orma communities are already growing tomatoes and other vegetables on a commercial scale in the lower Delta.

In order to make this sector a success it will be necessary to set up a chain of national outlets for the produce, which would be transported in refrigerated container trucks directly to markets in 10-15 hours. Concentration on high value produce like peppers, tomatoes, and other salad vegetables could generate turnover in excess of 3.5 billion KSh a year by 2030. With the addition of rice and fruit production the gross turnover in agricultural produce from communal and commercial farming enterprises could reach 3.8 billion KSh a year by 2030 and 6 billion KSh by 2050.

A major contribution to the local economy of the Delta would come from new products and jobs created through development of food processing and manufacturing. Projection of the potential for value added economic activity is very difficult given the timescales and uncertainties of how markets will develop over thirty years or more but taking a range of conservative estimates the total value is expected to lie in the range of 4-9 billion KSh per annum with an assumed value of 5 billion KSh by 2050 in order to complete the analysis for Figure 7.4 and table 7.3.

As shown in Table 7.2, other sectors of the local economy would add 2.75 billion KSh (cattle rearing) and 1.3 billion KSh (Natural Resources, house-building, charcoal and fuelwood) in 2030. By 2050, the contribution from cattle rearing would remain constant at KSh 2.75 billion. The value of natural resource harvesting, house-building, charcoal and fuelwood would also remain static at KSh 1.3 billion in 2050, but alternative technologies including solar power and use of new building materials would add a further KSh 1.3 billion.

7.5 Impacts on and Relating to Nature

Scenario C places a strong emphasis on developing both subsistence and commercial agriculture and manufacturing and industry. In consequence there will be pressures on natural resources in the Delta, particularly in terms of conversion of wet grassland to farming areas. These pressures will need to be managed carefully by introducing local settlement development action plans, and an overall management plan for the core area of the Ramsar site in order to prevent random growth and development which could fragment the ecosystem and cause disproportionate damage to precious habitats. At the same time, however, the choice of farming systems and crops would introduce relatively low increases in demand for water and the overall use of water in the Delta would increase by only 4% by 2050.

Table 7.2 Jobs by Activity (FTE)

Land Use Activities	2030	2050
Cattle (All)	1271.0	1271.0
Cattle on ranches	1475.0	1475.0
Milk	0.8	0.8
Subsistence Farming	209.0	379.0
Commercial Farming	0.0	0.0
Rice Farming	651.0	911.0
Intensive Vegetable farming	1848.0	3696.0
Extensive Vegetable farming	697.0	1394.0
Sugar production	0.0	0.0
Fruit farming	479.0	958.0
Fishing	0.0	0.0
Beekeeping	36.0	90.0
Natural Resources	134.0	134.0
Housing	779.0	779.0
New houses	0.0	951.0
Charcoal and Fuel wood	396.5	396.5
Alternative heating/power	0.0	350.0
Oil and Gas	0.0	0.0
Salt	252.0	252.0
Industry and Manufacturing	0.0	0.0
Trade, Commerce and Finance	210.0	393.0
Construction	15.1	20.2
Wholesale and Retail Trade	0.0	0.0
Tourism	46.5	78.5
Professional Services	0.0	0.0
Public Administration	0.0	0.0
Nature Conservation	0.0	0.0
Urban Development	0.0	0.0
Domestic Water Use	0.0	0.0
Totals	8499.9	13529.0

Source: Tana Delta Land Use Plan, 2014

Introduction of cattle management schemes and a reduction in the size of the permanent number of livestock would have major benefits for nature conservation, with improvement in the condition of the remaining areas of wet grassland. This would both enhance natural resource products and create ideal conditions for the development of eco-tourism.

Areas of scrub and thicket close to the floodplain are known to be of particular value for some species of small birds which are endemic to the region and more research is needed to establish the extent of their breeding zone. The areas of thicket and scrub on the upper terraces would come under increasing pressure for land conversion and it would be essential to develop and maintain wildlife migratory corridors which could also be used as droving routes for cattle, linking the core Delta with the outer rangelands. Ultimately, areas close to the main roads would lose much of their nature conservation value, but this is the predominant habitat type throughout most of North East Kenya so the consequences would not be too severe.

Important changes are likely to occur in the lower Tana Delta in those parts of the floodplain that lie at or below existing sea level. Current projections of global warming include the possibility that mean sea level could rise along the Kenyan coast by 0.25 metres by mid-century and 0.5

Table 7.3 Value of Different Activities (KSh)

Land Use Activities	2030	2050
Cattle (All)	1271.0	1271.0
Cattle on ranches	1475.0	1475.0
Milk	0.8	0.8
Subsistence Farming	209.0	379.0
Commercial Farming	0.0	0.0
Rice Farming	651.0	911.0
Intensive Vegetable farming	1848.0	3696.0
Extensive Vegetable farming	697.0	1394.0
Sugar production	0.0	0.0
Fruit farming	479.0	958.0
Fishing	0.0	0.0
Beekeeping	36.0	90.0
Natural Resources	134.0	134.0
Housing	779.0	779.0
New houses	0.0	951.0
Charcoal and Fuel wood	396.5	396.5
Alternative heating/power	0.0	350.0
Oil and Gas	0.0	0.0
Salt	252.0	252.0
Industry and Manufacturing	0.0	0.0
Trade, Commerce and Finance	210.0	393.0
Construction	15.1	20.2
Wholesale and Retail Trade	0.0	0.0
Tourism	46.5	78.5
Professional Services	0.0	0.0
Public Administration	0.0	0.0
Nature Conservation	0.0	0.0
Urban Development	0.0	0.0
Domestic Water Use	0.0	0.0
Totals	8499.9	13529.0

Source: Tana Delta Land Use Plan, 2014

metres by 2100. This level of increase would convert some parts of the lower Delta to brackish salt-marsh rather than wet grassland. There would be a marked change in flora and fauna as a result, but this would not destroy the scientific and ecological importance of the Delta; instead it could increase its significance for scientific research and the development of coping mechanisms and adaptive management techniques for handling climate change at the international level.

7.6 Culture

The concepts for future land management in the Tana Delta that are explored in Scenario C will require increased cooperation between pastoral communities in managing livestock and similar demands for cooperation between farming communities in the development of joint enterprises between groups of farmers and business partners. These adjustments will call for radical shifts in local cultures where family groups have traditionally been able to migrate to new areas following displacement from their homes after famines or droughts. Many of the existing settlements in the Delta have been relocated three or four times since they were first founded half a century ago, while others have only been established in the last twenty years. Freedom to migrate to new areas will be increasingly curtailed as the population rises and land becomes more heavily settled.

It will be increasingly important to restrict areas of new housing to existing settlements if the overriding aim is to preserve the core area of the Delta in its natural state where uses are restricted to traditional livestock

grazing, farming and the harvesting of natural produce. If isolated settlements were allowed to proliferate this would increase competition for land and water and ultimately destroy the existing patterns of land use on which individual pastoralist, farming, fishing and natural resource harvesting cultures are based.

7.7 Security

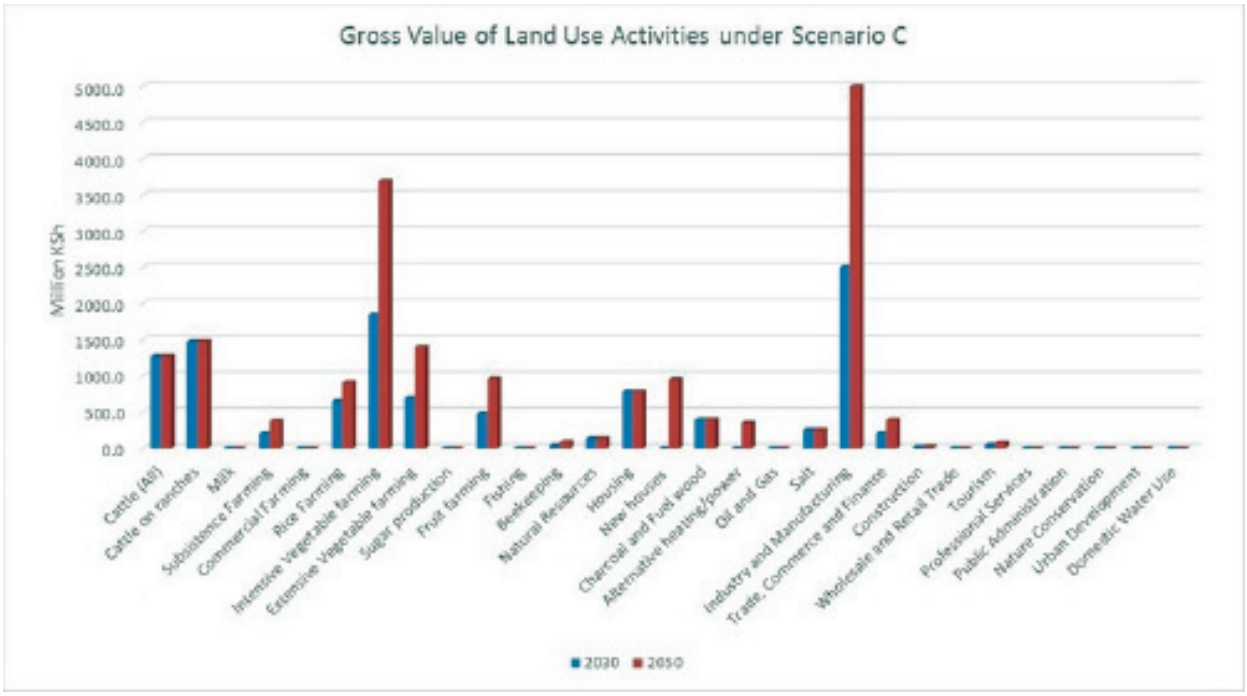
The process of reducing current tensions in the Tana Delta over land and water resources will not be achieved overnight. Instead it will need to follow a series of steps. The first objective should be to introduce the concepts of sharing resources, which underpins all of the analysis set out in this SEA. There needs to be a common understanding between pastoralists and farmers that both groups have legitimate rights to share the resources of the Delta and an acceptance of the basis on which this division will be made. This is the principle of restricting cattle rearing and farming to discrete areas in the Delta.

If this fundamental principle can be agreed, as articulated in Scenario C and the preferred land use strategy, then the next step will be to demarcate actual areas on the ground. Historically, enormous levels of distrust have been built up amongst local people because of the opaque and, in some cases, devious techniques used by both government and private investors to mark the boundaries of disputed ownerships.

Under the new approach set out in the Tana Delta LUP, the process of demarcating settlement boundaries and related land use management areas will be carried out jointly by the County Councils, village elders and the community at large, with the involvement of government agencies like KWS and KFS where appropriate.

In addition to physical survey and identification of land parcel boundaries, a parallel process of resolving historical injustices over land allocation and rationalising land holdings will be required involving the National Land Commission, the Courts and government at both National and Local level. The final resolution of conflict in the Tana Delta will only come about when all people accept that their grievances have been treated fairly and future land grabbing becomes an impossibility.

Figure 7.4: Gross Value of Economic Activities in 2030 and 2050 under Scenario C



Source: Tana Delta Land Use Plan, 2014

CHAPTER 8 Summary of Findings on the Existing Situation and Three Scenarios

Introduction

The preceding four chapters have analysed the likely impacts and outcomes of the existing baseline and potential scenarios on a topic by topic basis, using seven key indicators of change. In this chapter, the findings are brought together by comparing the performance of the baseline and three scenarios against each other, using the following key indicators:

1. *Demand for land for the principal land uses and economic activities envisaged in the Tana Delta,*
2. *Water requirements for the principal land uses and economic activities,*
3. *Job creation and impacts on livelihoods arising from (1),*
4. *Economic value of the planned land uses and activities.*
5. *Social Impacts*
6. *Impact on Biodiversity*

8.1 Demand for Land

The assessment of land requirements for each type of economic activity is relatively straightforward, but interpreting the cumulative effect of different demands on the finite resources within the Delta is more complicated.

First, there is great variation in terms of exactly which parts of the Delta might be developed for particular uses; for example, a new commercial vegetables farm.

Second, as one type of land use activity expands it will have inevitable consequences for others by forcing them to occupy smaller areas; where two major uses are in direct competition, as in the case of livestock grazing and farming, the outcome may be very uncertain.

Third, many land uses can be carried out simultaneously on the same area of land; at one level of production these uses may be sustainable (nature conservation, natural resource harvesting and limited grazing in forests) but if competition increases, productivity will fall and ultimately the resource itself will be destroyed.

These variables have been assessed in general terms in examining the effects of different scenarios and some initial conclusions are drawn below. It must be noted, however, that these are only indicative and cannot be relied upon to predict the future of the Delta.

Tables 8.1 and 8.2 show the amount of land needed to support specific economic activities in their own right, without any consideration of the practicalities of meeting these needs in 2030 and 2050. The cumulative figures generated through this process are greatly in excess of the land area in the Tana Delta, indicating that major compromises and trade-offs would be needed between the different interests.

The information in Table 8.1 and Table 8.2 has been used to construct representative changes in the basic land use types within the Delta Plan Area as shown in Tables 8.3 and 8.4 and Figures 8.1 and 8.2. Scenario A, continuation of traditional livelihoods, has the greatest impact in land demand, due to assumed expansion in the number of livestock. Scenario B causes the greatest changes from natural habitats to commercial cultivation, while Scenario C largely maintains the status quo.

Table 8.1 Demand for Land by Different Economic Activities; All Scenarios in 2030

LAND DEMAND	Existing	2030		
		Scenario A 2030	Scenario B 2030	Scenario C 2030
	Area (Kms)	Area (Kms)	Area (Kms)	Area (Kms)
Cattle (All)	1,000	5,119	750	400
Cattle on ranches	900	900	1,150	1,150
Milk	0	0	0	0
Subsistence Farming	61	104	501	203
Commercial Farming	4	10	0	0
Rice Farming	3	3	50	31
Intensive Vegetable farming	0	0	5	30
Extensive Vegetable farming	0	0	50	10
Sugar production	0	0	100	0
Fruit farming	0	0	3	10
Food Relief	0	0	0	0
Fishing	0	0	0.25	0.25
Beekeeping	0	0	0	0
Natural Resources	436	436	436	436
Housing	0	0	0	0
New houses	0	0	0	0
Charcoal and Fuel wood	750	1,230	1,230	750
Alternative heating/power	0	0	0	0
Oil and Gas	0	0	0	0
Salt	5	5	5	5
Industry and Manufacturing	0	0	1.2	1.2
Trade, Commerce and Finance	0	0	0	0
Construction	0	0	0	0
Wholesale and Retail Trade	0	0	0.5	1
Tourism	0	0	0	0
Professional Services	0	0	0	0
Public Administration	0	0	0	0
Nature Conservation	1,036	1,036	1,036	1,407
Urban Development	14	44	44	44
Domestic Water Use	0	0	0	0
Totals	4,209	8,887	5,361	4,478

Source: Tana Delta SEA, 2014

Table 8.2 Demand for Land by Different Economic Activities; All Scenarios in 2050

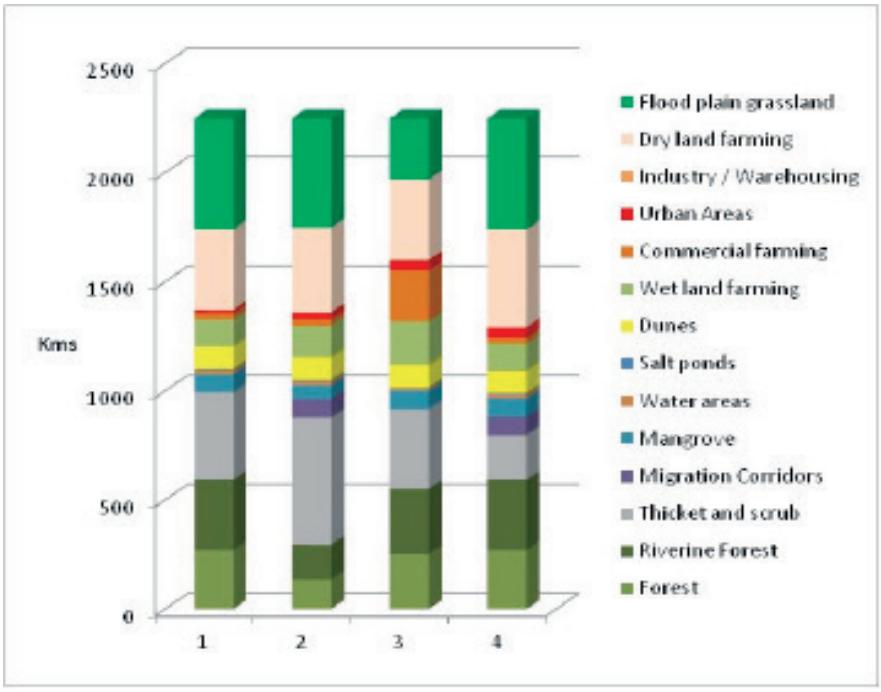
LAND DEMAND		2050		
		Scenario A 2050	Scenario B 2050	Scenario C 2050
		Area (Kms)	Area (Kms)	Area (Kms)
Open Grazing		13,760	750	400
Cattle on ranches		900	1,150	1,150
Milk		0	0	0
Subsistence Farming		189	908	250
Commercial Farming		20	0	0
Rice Farming		3	100	31
Intensive Vegetable farming		0	10	40
Extensive Vegetable farming		0	100	10
Sugar production		0	200	0
Fruit farming		0	5	20
Food Relief		0	0	0
Fishing		0	0.50	0.25
Beekeeping		0	0	0
Natural Resources		436	436	436
Housing		0	0	0
New Houses		0	0	0
Charcoal and Fuel wood		2,220	1,230	750
Alternative heating/power		0	0	0
Oil and Gas		0	0	0
Salt		5	5	5
Industry and Manufacturing		0	3	3
Trade, Commerce and Finance		0	0	0
Construction		0	0	0
Wholesale and Retail Trade		0	1	1
Tourism		0	0	0
Professional Services		0	0	0
Public Administration		0	0	0
Nature Conservation		1,036	1,036	1,407
Urban Development		80	80	80
Domestic Water Use		0	0	0
Totals		18,649	6,015	4,583

Source: Tana Delta Land Use Plan, 2014

Table 8.3 Gross Demand for Land for Scenarios A, B & C in 2030 Compared with the Existing Situation in 2010

LAND DEMAND	Existing	2030		
		Scenario A 2030	Scenario B 2030	Scenario C 2030
	Area (Kms)	Area (Kms)	Area (Kms)	Area (Kms)
Forest	271	136	252	271
Riverine Forest	323	162	300	323
Thicket and scrub	400	581	365	204
Migration Corridors	0	86	0	86
Mangrove	84	64	84	84
Water areas	18	18	10	18
Salt ponds	5	5	5	5
Dunes	103	103	103	103
Wet land farming	123	145	200	123
Commercial farming	31	31	236	31
Urban Areas	14	30	44	44
Industry / Warehousing	0	0	1	0
Dry land farming	370	390	370	450
Flood plain grassland	508	500	280	508
Total	2250	2250	2250	2250

Figure 8.1 Gross Demand for Land for Scenarios A, B & C in 2030 Compared with the Existing Situation in 2010



Note: 1= Existing; 2 = Scenario A; 3 = Scenario B; 4 = Scenario C

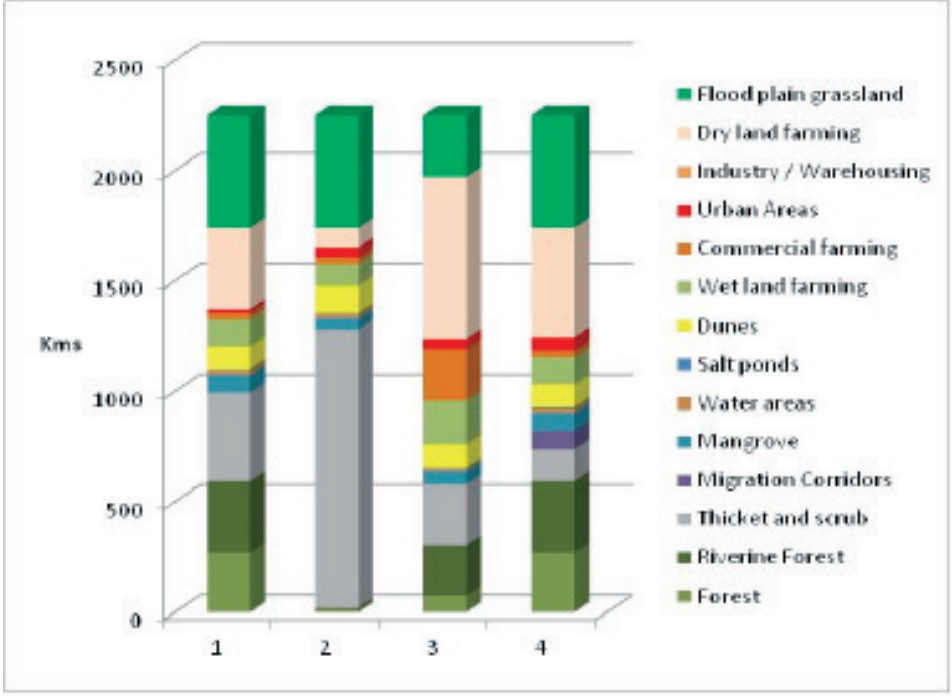
Source: Tana Delta SEA, 2014

Table 8.4 Gross Demand for Land for Scenarios A, B & C in 2050 Compared with the Existing Situation in 2010

LAND DEMAND	Existing	2050		
		Scenario A 2050	Scenario B 2050	Scenario C 2050
	Area (Kms)	Area (Kms)	Area (Kms)	Area (Kms)
Forest	271	10	75	271
Riverine Forest	323	10	230	323
Thicket and scrub	400	1262	275	142
Migration Corridors	0	0	0	86
Mangrove	84	50	60	84
Water areas	18	18	10	18
Salt ponds	5	5	5	5
Dunes	103	123	103	103
Wet land farming	123	100	200	123
Commercial farming	31	31	236	31
Urban Areas	14	44	44	60
Industry / Warehousing	0	0	1	0
Dry land farming	370	89	733	496
Flood plain grassland	508	508	278	508
Total	2250	2250	2250	2250

Source: Tana Delta SEA, 2014

Figure 8.2 Gross Demand for Land for Scenarios A, B & C in 2050 Compared with the Existing Situation



Source: Tana Delta SEA, 2014

8.1.1 Commentary

Under Scenario A (2) continued expansion in the number of livestock leads to increasing damage to accessible natural habitats and a reduction in farming areas. Forests and areas of dry farmland are reduced to degraded thicket and scrub cover. The core area of the floodplain remains intact but its biodiversity is greatly reduced through over-grazing. Population growth cannot be sustained and the Tana Delta becomes ungovernable as rival communities clash continuously.

Under Scenario B (3) the creation of 235 square kilometres of commercial farming and irrigated industrial cropping of sugarcane destroys the heart of the floodplain, reducing the remaining wet grasslands to less than half their present extent. Subsistence farming is driven into the drier areas and results in conversion of thicket and scrub to dryland farming. The scale of land use change causes massive social disruption, 30,000 – 40,000 inhabitants have to be resettled on marginal land or relocated on new irrigated areas far removed from the Tana Delta. The degree of social readjustment required under this scenario is unlikely to be achieved without massive conflict and the destruction of the Delta environment.

Scenario C (4) requires a high degree of compromise between farming and pastoral communities in order to maintain the present extent of the floodplain wet grasslands and expand commercial and communal farming by cultivating and irrigating areas of current thicket and scrub. It also requires major emphasis on creating new economic activities through value addition and industrial development. It offers a way forward which would avoid conflict and benefit all sectors of society, while also greatly increasing food production and achieving food security for the Delta and protecting its biodiversity and tourism potential.

8.2 Water Requirements

The annual water demand of the three scenarios (expressed as the equivalent of m3/sec) is shown in Table 8.5 and Figure 8.3. Individual demands for the different economic activities included in each scenario are shown in tables 9.6 and 9.7. The relative difference between the three scenarios is partially masked in Figure 9.3 by the fact that all scenarios utilise the full capacity of the River Tana to support existing livelihoods, economic activities and the ecosystem. The information is therefore presented in a different format in Figure 9.4, by excluding the current baseline demand of 60m3/sec.

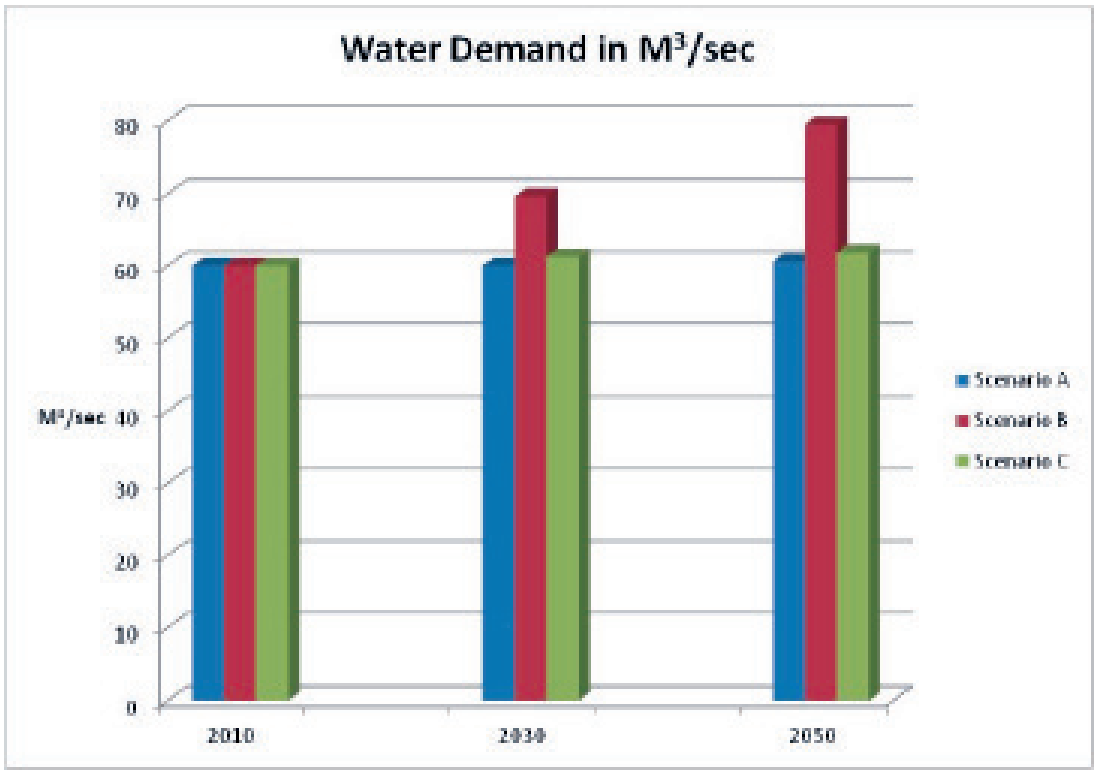
The analysis shows clearly that both scenarios A and C make only a small increase in demand for water (with increases of 1.3% and 3% respectively by 2050). However, development of a large irrigation scheme for sugar production and other commodities in Scenario B would lead to a 32% increase of 19.51 M3/sec above the existing levels, which would not be environmentally sustainable, even if increased storage were provided in the upper River Tana (since most of the stored water would be lost through evaporation and seepage in the middle River Tana catchment).

Table 8.5 Demand for Water in M^3/Sec for Each Scenario in 2010, 2030 and 2050

	2010	2030	2050
Scenario A	60	60.02	60.62
Scenario B	60	69.63	79.51
Scenario C	60	61.24	61.84

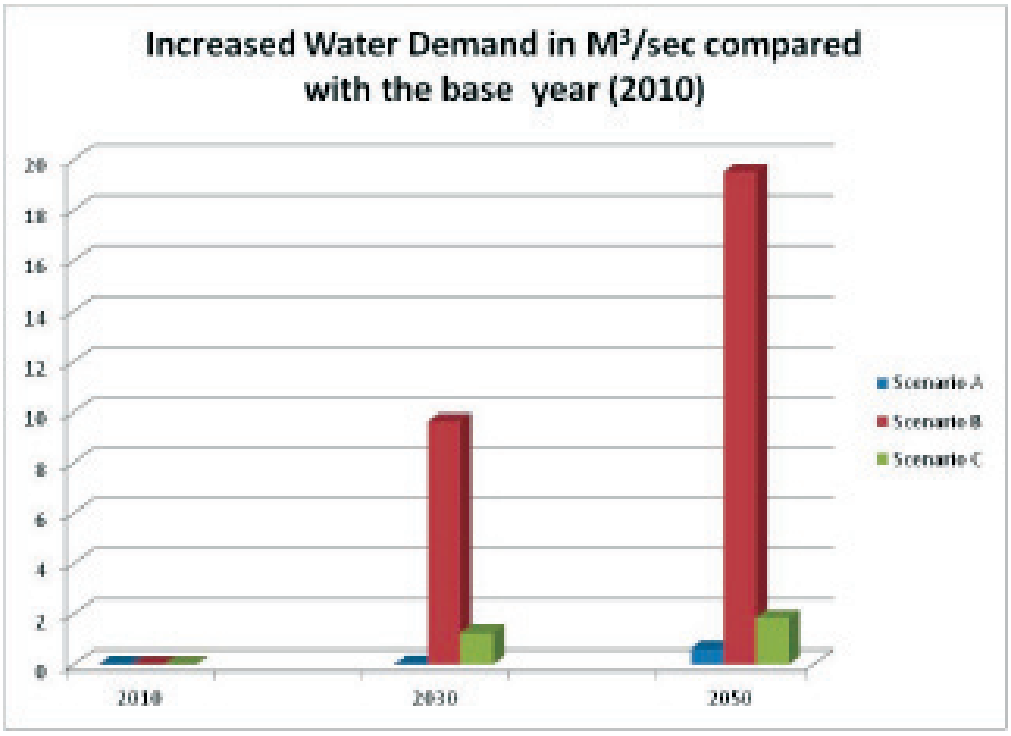
Source: Tana Delta SEA, 2014

Figure 8.3 Demand for Water in M³/Sec for Each Scenario in 2010, 2030 and 2050



Source: Tana Delta SEA, 2014

Figure 8.4 Increase in Water Demand over the Base Rate of 60m³/sec



Source: Tana Delta SEA, 2014

Table 8.6 Water Demand for Economic Activities under each Scenario in the Year 2030

Economic Activity	Existing		Scenario A 2030		Scenario B 2030		Scenario C 2030	
	Annual Mm^3	M3/sec	Annual Mm^3	M3/sec	Annual Mm^3	M3/sec	Annual Mm^3	M3/sec
Open Grazing	15.5	0.49	17	0.53	17	0.53	14	0.45
Ranches / commercial grazing	0	0	2.96	0.09	0.03	0.00	0	0.00
Subsistence Farming	0	0	0	0.00	0	0.00	0	0.00
Commercial Farming	2.7	0.09	9.85	0.31	0	0.00	0	0.00
Rice Farming	0	0.00	0.00	0.00	35	1.10	21.5	0.68
Intensive Vegetable farming	0	0.00	0.00	0.00	3	0.10	15	0.48
Extensive Vegetable farming	0	0.00	0.00	0.00	25	0.79	5	0.16
Sugar production	0	0.00	0.00	0.00	250	7.93	0	0.00
Fruit farming	0	0.00	0.00	0.00	3	0.10	12	0.38
Food Relief	0	0.00	0.00	0.00	0	0	0	0.00
Fishing	0	0.00	0.00	0.00	0	0	0	0.00
Beekeeping	0	0.00	0.00	0.00	0	0	0	0.00
Natural Resources	0	0.00	0.00	0.00	0	0	0	0.00
Housing	0	0.00	0.00	0.00	0	0	0	0.00
Charcoal and Fuel wood	0	0.00	0.00	0.00	0	0	0	0.00
Oil and Gas	0	0.00	0.00	0.00	0	0	0	0.00
Heavy Mineral Sands	0	0.00	0.00	0.00	0	0	0	0.00
Industry and Manufacturing	0	0.00	0.00	0.00	0	0	0	0.00
Trade, Commerce and Finance	0	0.00	0.00	0.00	0	0	0	0.00
Construction	0	0.00	0.00	0.00	0	0	0	0.00
Wholesale and Retail Trade	0	0.00	0.00	0.00	0	0	0	0.00
Tourism	0	0.00	0.00	0.00	0	0	0	0.00
Professional Services	0	0.00	0.00	0.00	0	0	0	0.00
Public Administration	0	0.00	0.00	0.00	0	0	0	0.00
Nature Conservation	1861	59.01	1861	59.01	1861	59.01	1861	59.01
Urban Development	0	0.00	0.00	0.00	0	0.00	0	0.00
Domestic Water Use	0.745	0.02	2.50	0.08	2.50	0.08	2.50	0.08
Totals	1880	60	1,893	60.02	2,196	69.63	1,931	61.24

Source: Tana Delta SEA, 2014

Table 8.7 Water Demand for Economic Activities under each Scenario in the Year 2050

Economic Activity	Scenario A 2050		Scenario B 2050		Scenario C 2050	
	Annual Mm^3	M3/sec	Annual Mm^3	M3/sec	Annual Mm^3	M3/sec
Open Grazing	20.74	0.66	17	0.53	14	0.45
Ranches / commercial grazing	5.35	0.17	0.03	0.00	0.03	0.00
Subsistence Farming	0	0.00	0	0.00	0.00	0.00
Commercial Farming	20	0.63	0	0.00	0.00	0.00
Rice Farming	0	0.00	70	2.22	21.50	0.68
Intensive Vegetable farming	0	0.00	5	0.16	20.00	0.63
Extensive Vegetable farming	0	0.00	50	1.59	5.00	0.16
Sugar production	0	0.00	500	15.85	0.00	0.00
Fruit farming	0	0.00	6	0.00	24.00	0.76
Food Relief	0	0.00	0.00	0.00	0.00	0.00
Fishing	0	0.00	0.00	0.00	0.00	0.00
Beekeeping	0	0.00	0.00	0.00	0.00	0.00
Natural Resources	0	0.00	0.00	0.00	0.00	0.00
Housing	0	0.00	0.00	0.00	0.00	0.00
Charcoal and Fuel wood	0	0.00	0.00	0.00	0.00	0.00
Oil and Gas	0	0.00	0.00	0.00	0.00	0.00
Heavy Mineral Sands	0	0.00	0.00	0.00	0.00	0.00
Industry and Manufacturing	0	0.00	0.00	0.00	0.00	0.00
Trade, Commerce and Finance	0	0.00	0.00	0.00	0.00	0.00
Construction	0	0.00	0.00	0.00	0.00	0.00
Wholesale and Retail Trade	0	0.00	0.00	0.00	0.00	0.00
Tourism	0	0.00	0.00	0.00	0.00	0.00
Professional Services	0	0.00	0.00	0.00	0.00	0.00
Public Administration	0	0.00	0.00	0.00	0.00	0.00
Nature Conservation	1861	59.01	1861	59.01	1861	59.01
Urban Development	0	0.00	0	0.00	0	0.00
Domestic Water Use	4.6	0.15	4.6	0.15	4.60	0.15
Totals	1,912	60.62	2,514	79.51	1,950	61.84

Source: Tana Delta SEA, 2014

8.3 Job Creation

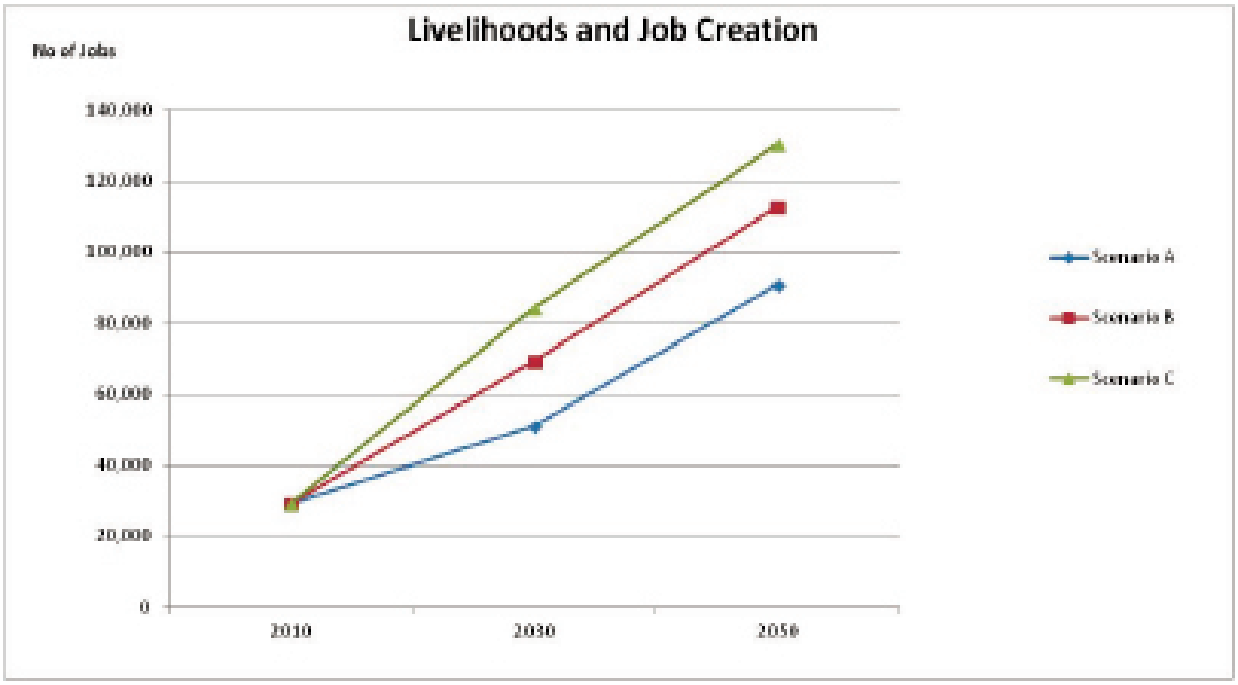
Information provided in Table 8.8 and Figure 8.5 indicates the number of jobs and livelihoods that would be created under each of the three scenarios, by the specific economic activities listed separately in Tables 8.9 and 8.10. These estimates do not take into account the number of livelihoods that would be displaced in developing new economic activities and this analysis will be included in the final assessment.

Table 8.8 Number of Jobs Generated under each Scenario

	2010	2030	2050
Scenario A	29,242	51,065	90,732
Scenario B	29,242	69,215	112,648
Scenario C	29,242	84,428	130,496

Source: Tana Delta SEA, 2014

Figure 8.5 Number of Jobs Generated under each Scenario



Source: Tana Delta SEA, 2014

Table 8.9 Jobs and Livelihoods Created by Economic Activity by 2030

LIVELIHOODS / JOBS	Existing	2030		
		A	B	C
Open Grazing	1,736	2,934	2,934	250
Ranches / commercial grazing	2	160	100	1,500
Subsistence Farming	12,409	20,913	20,913	33,550
Commercial Farming	77	200	0	0
Rice Farming	0	0	500	310
Intensive Vegetable farming	0	0	500	12,000
Extensive Vegetable farming	0	0	500	50
Sugar production	0	0	10,000	0
Fruit farming	0	0	2,000	5,000
Fishing	450-700	1,000	1,200	1,200
Beekeeping	140	480	480	480
Natural Resources	4,971	8,365	8,365	8,365
Housing	633	1,518	1,518	1,518
Charcoal and Fuel wood	4,971	8,365	8,365	8,365
Oil and Gas	0	0	50	50
Heavy Mineral Sands	0	0	200	0
Industry and Manufacturing	0	0	3,600	3,900
Trade, Commerce and Finance	3,488	5,870	5,870	5,870
Construction	0	250		
Wholesale and Retail Trade	600	600	600	500
Tourism	200	400	400	400
Professional Services	5	10	20	20
Public Administration	0	60	850	850
Nature Conservation	10	100	250	250
Urban Development	0	0	0	0
Water Resources	0	0	0	0
Totals	29,242	51,225	69,215	84,428

Source: Tana Delta SEA, 2014

Table 8.10 Jobs and Livelihoods Created by Economic Activity by 2050

LIVELIHOODS / JOBS	2050		
	A	B	C
Open Grazing	5299	5,299	250
Ranches / commercial grazing	320	100	1,500
Subsistence Farming	37861	37,861	60,000
Commercial Farming	400	0	0
Rice Farming	0	1,000	310
Intensive Vegetable farming	0	1,000	16,000
Extensive Vegetable farming	0	1,000	50
Sugar production	0	20,000	0
Fruit farming	0	2,000	10,000
Fishing	1366	1,400	1,200
Beekeeping	7200	720	720
Natural Resources	15144	8,365	8,365
Housing	3370	3,370	1,518
Charcoal and Fuel wood	15144	8,365	8,365
Oil and Gas	0	50	50
Heavy Mineral Sands	0	300	0
Industry and Manufacturing	0	7,200	7,800
Trade, Commerce and Finance	3,488	10,628	10,628
Construction	0	250	
Wholesale and Retail Trade	600	600	600
Tourism	200	800	800
Professional Services	20	40	40
Public Administration	120	1,800	1,800
Nature Conservation	200	500	500
Urban Development	0	0	0
Water Resources	0	0	0
Totals	90,732	112,648	130,496

Source: Tana Delta SEA, 2014

8.4 Economic Value

The relative economic value of the three scenarios is shown in Table 8.11 and Figure 8.6. These are based on the gross addition of the value of all potential developments examined under each scenario without considering the practicalities of physically accommodating them all in the Plan area. The full range of values is broken down by activity in the time frames of 2030 and 2050 in Table 8.12 and 8.13.

In the case of Scenario A the main economic value is generated by assuming that the size of the permanent cattle herd could be increased to match the aspirations of pastoralists to own their own herds. This is completely impractical because an area two and a half times the size of the Delta would be needed to provide sufficient grazing.

In the case of Scenario B, the accumulated value arises from the fact that a large number of competing land uses are included (included irrigated rice and sugar in addition to expansion of subsistence and community farming). There is insufficient land or water to accommodate all of these potential uses and the social and biophysical consequences would be disastrous, resulting in uncontrollable instability and conflict within a few years.

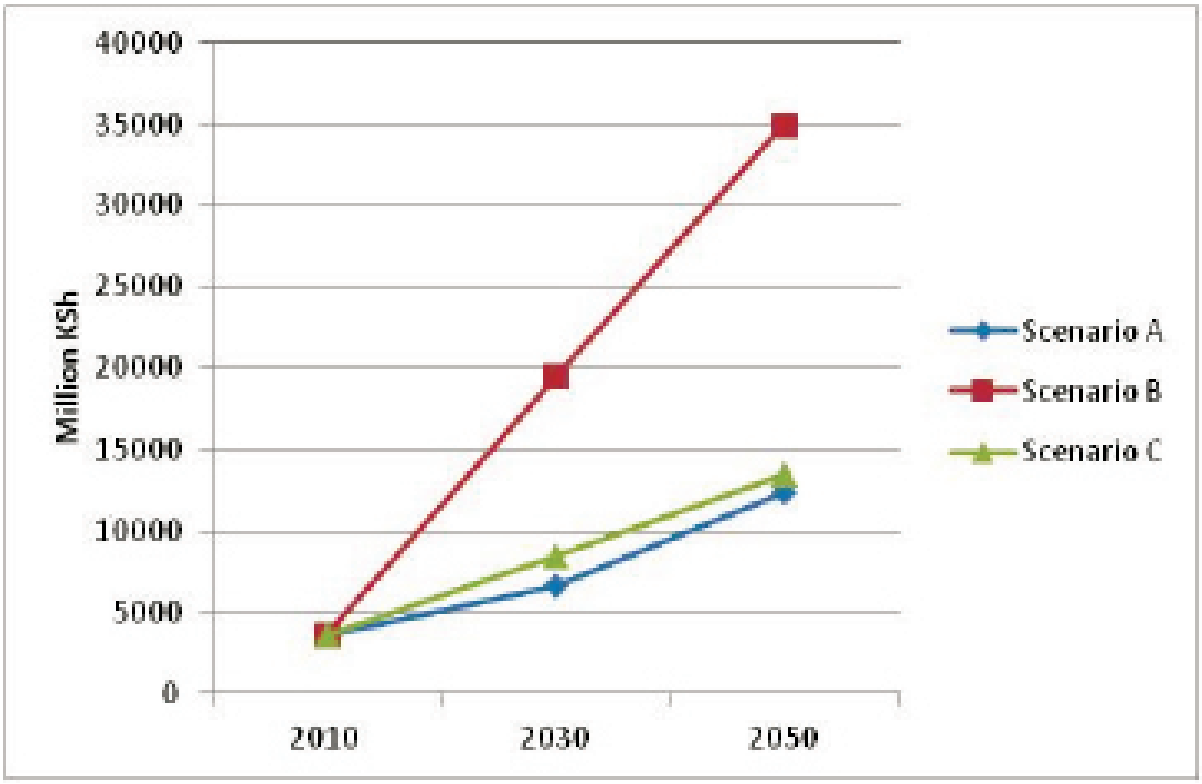
Only Scenario C approaches a realistic allocation of land uses that could be accommodated within the physical and socio-economic constraints of the Delta.

Table 8.11 Notional Economic Value Assessed in KSh Million for the Three Scenarios

	2010	2030	2050
Scenario A	3644	6720	12438
Scenario B	3644	19471	34987
Scenario C	3644	8500	13529

Source: Tana Delta SEA, 2014

Figure 8.6 Notional Economic Value Assessed in KSh Million for the Three Scenarios



Source: Tana Delta SEA, 2014

Table 8.12 Full Range of Economic Activities Considered in the Three Scenarios in the Year 2030

LIVELIHOODS / JOBS	Existing	2030		
		Scenario A	Scenario B	Scenario C
	Gross value	Gross value	Gross value	Gross value
Cattle (All)	2542.0	4288.0	2542.0	1271.0
Cattle on ranches	3.1	386.1	1000.0	1475.0
Milk	0.8	0.0	0.8	0.8
Subsistence Farming	62.0	105.0	105.0	209.0
Commercial Farming	9.9	88.2	0.0	0.0
Rice Farming	0.0	0.0	1050.0	651.0
Intensive Vegetable farming	0.0	0.0	1848.0	1848.0
Extensive Vegetable farming	0.0	0.0	697.0	697.0
Sugar production	0.0	0.0	9744.0	0.0
Fruit farming	0.0	0.0	118.0	479.0
Food Relief	0.0	0.0	0.0	0.0
Fishing	53.1	65.2	497.5	0.0
Beekeeping	10.0	36.0	36.0	36.0
Natural Resources	80.0	134.0	134.0	134.0
Housing	324.6	779.0	779.0	779.0
New houses	0.0	0.0	0.0	0.0
Charcoal and Fuel wood	194.5	396.5	396.5	396.5
Alternative heating/power	0.0	0.0	0.0	0.0
Oil and Gas	0.0	0.0	0.0	0.0
Salt	252.0	252.0	252.0	252.0
Industry and Manufacturing	0.0	0.0	0.0	0.0
Trade, Commerce and Finance	94.0	160.0	210.0	210.0
Construction	0.0	0.0	15.1	15.1
Wholesale and Retail Trade	0.0	0.0	0.0	0.0
Tourism	17.6	30.0	46.5	46.5
Professional Services	0.0	0.0	0.0	0.0
Public Administration	0.0	0.0	0.0	0.0
Nature Conservation	0.0	0.0	0.0	0.0
Urban Development	0.0	0.0	0.0	0.0
Domestic Water Use	0.0	0.0	0.0	0.0
Totals	3,644	6,720	19,471	8,500

Source: Tana Delta SEA, 2014

Table 8.13 Full Range of Economic Activities Considered in the Three Scenarios in the Year 2050

LIVELIHOODS / JOBS	2050		
	Scenario A	Scenario B	Scenario C
	Gross value	Gross value	Gross value
Open Grazing	7744.0	2542.0	1271.0
Cattle on ranches	772.3	1000.0	1475.0
Milk	0.0	0.8	0.8
Subsistence Farming	189.0	189.0	379.0
Commercial Farming	268.0	0.0	0.0
Rice Farming	0.0	2940.0	911.0
Intensive Vegetable farming	0.0	3696.0	3696.0
Extensive Vegetable farming	0.0	1394.0	1394.0
Sugar production	0.0	19404.0	0.0
Fruit farming	0.0	235.0	958.0
Food Relief	0.0	0.0	0.0
Fishing	89.2	142.0	0.0
Beekeeping	90.0	90.0	90.0
Natural Resources	242.0	134.0	134.0
Housing	1730.0	779.0	779.0
New Houses	0.0	951.0	951.0
Charcoal and Fuel wood	714.0	396.5	396.5
Alternative heating/power	0.0	350.0	350.0
Oil and Gas	0.0	0.0	0.0
Salt	252.0	252.0	252.0
Industry and Manufacturing	0.0	0.0	0.0
Trade, Commerce and Finance	288.0	393.0	393.0
Construction	0.0	20.2	20.2
Wholesale and Retail Trade	0.0	0.0	0.0
Tourism	60.0	78.5	78.5
Professional Services	0.0	0.0	0.0
Public Administration	0.0	0.0	0.0
Nature Conservation	0.0	0.0	0.0
Urban Development	0.0	0.0	0.0
Domestic Water Use	0.0	0.0	0.0
Totals	12,438	34,987	13,529

Source: Tana Delta SEA, 2014

8.5 Adjustments to the Economic Values of the Three Scenarios

In order to adjust Scenarios A and B to represent a more realistic picture of economic development, a modification or variant of Scenario A (A1) was produced which limits the number of cattle to the existing carrying capacity of the Delta. In addition, Scenario B1 was produced to represent a maximum level of irrigation potential by excluding sugar production (which has the highest water demand and causes maximum disruption to existing land uses, livelihoods and biodiversity).

The consequences of these adjustments are shown in table 9.14 and figure 9.7.

The net result of the adjustments described above is to bring the economic value of the three scenarios more closely into line with a range from KSh 7.2 to 15.6 Billion. Scenario A relying on traditional livelihoods would have a value roughly half that of the other two. However, the difference between Scenarios B and C would only be 15% (2 billion KSh).

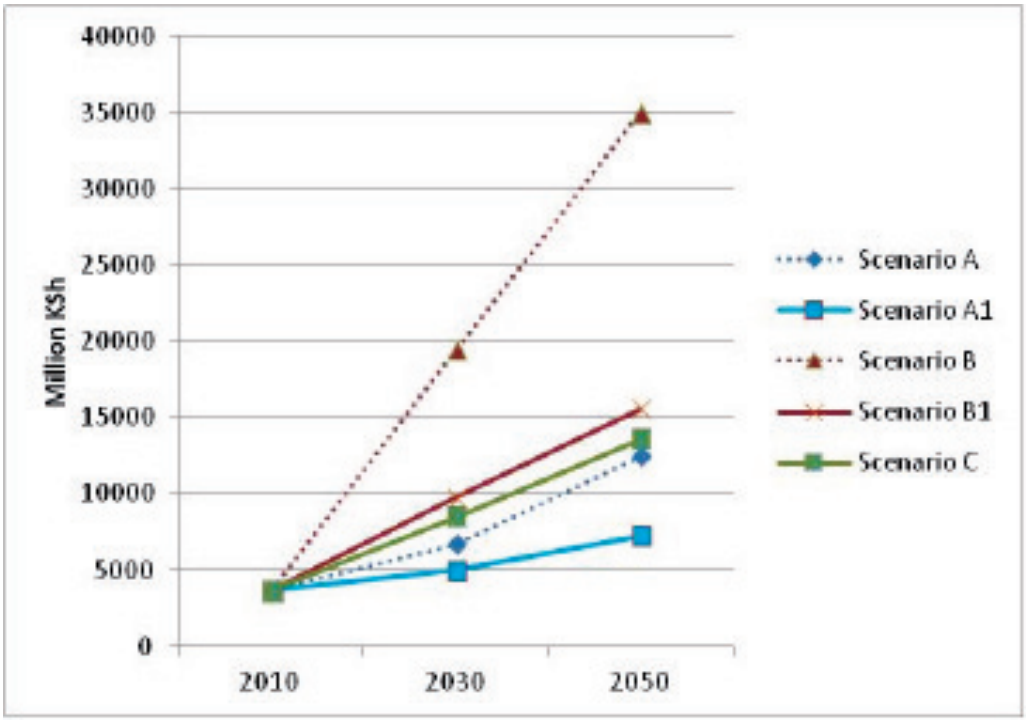
The net result of the adjustments described above is to bring the economic value of the three scenarios more closely into line with a range from KSh 7.2 to 15.6 Billion. Scenario A relying on traditional livelihoods would have a value roughly half that of the other two. However, the difference between Scenarios B and C would only be 15% (2 billion KSh).

Table 8.14 Addition of Scenarios A1 and B1 Showing Notional Economic Value Assessed in KSh Million

	2010	2030	2050
Scenario A	3644	6720	12438
Scenario A1	3644	4974	7236
Scenario B	3644	19471	34987
Scenario B1	3644	9727	15583
Scenario C	3644	8500	13529

Source: Tana Delta SEA, 2014

Figure 8.7 Addition of Scenarios A1 and B1 Showing Notional Economic Value Assessed in KSh Million



Source: Tana Delta SEA, 2014

8.6 Social and Cultural Impacts

Current social conditions in the Tana Delta are adversely affected by high levels of poverty, low levels of literacy and lack of opportunity to improve welfare and livelihoods. Each of the three scenarios would offer initial scope for improvement over the current conditions but pressures and conflicts would increase with rising population.

In the case of Scenario A, tensions between the farming and pastoral communities would be exacerbated by continuing growth and competition between these principal land uses as grazing activities encroached more heavily into existing farming areas, while farming practices were extended in turn into traditional grazing areas. In the absence of any significant new income sources the scope for tackling poverty and addressing welfare and educational constraints would be very much restricted.

Scenario B would provide much greater opportunity for raising individual income levels and stimulating the local economy but at the same time development of large commercial or industrial farming projects would cause massive disruption to existing communities' lifestyles and sources of livelihood based on livestock rearing and natural resource harvesting. The changes in land use and enforced resettlement of large numbers of people (in excess of 20,000 individuals) would cause bitter disputes and, given the recent clashes in the Tana Delta, it is hard to envisage how the changes could be managed without serious threats of violence.

Scenario C is designed to reduce the levels of both social and cultural impacts by setting out potential development programmes to benefit all sectors of the existing communities including cattle breeders, farmers and fishers. Since the areas of land involved are finite, a significant degree of compromise will be called for from all parties and it will take time to build trust in the new administrations (the County Governments) and ensure that all interests are treated fairly. Nevertheless, if the proposed land use strategy which is based on Scenario C is promoted vigorously, substantial improvements in economic conditions should be achieved within the first part of the plan period and this should help to reduce the current frictions between different land users.

8.7 Biodiversity Impacts

The Tana Delta is of international importance, primarily because of its wetland habitats, although these are not currently in ideal condition. Reduction in river flows, increased drought and rising sea level have contributed to some deterioration, together with increased disturbance and competition over resources.

In theory, Scenario A would create more sustainable forms of land use in the long term, but in practice, very different results are likely as the growing population seeks to exploit the same basic resources and competition intensifies between farming and livestock rearing.

Scenario B would have a dramatic impact on biodiversity by destroying the core area of floodplain grassland in a relatively short time (less than 20 years). Loss of prime woodland habitat and the conversion of thicket and scrub to farmland would leave very little of the current Ramsar site area intact.

Scenario C would see increasing pressures on some areas of the Delta from commercial grazing and communal and/or private sector farming projects, but the scenario is designed to retain the core area of the Delta intact and to offer significant opportunities to manage this area through community based programmes in order to stimulate nature conservation and create major tourism opportunities. This scenario is regarded as offering the best long term solution to wise use and sustainable development in the Delta.

CHAPTER 9 Conclusions and Recommendations

Introduction

This final chapter is divided into two parts. Part One discusses the principal findings of the SEA in relation to the wider issues affecting the whole of the River Tana basin, while Part Two examines the actions that are needed specifically within the Tana Delta.

PART ONE
The Tana River Basin

This part of the final chapter on conclusions and recommendations considers the macro-economic development trends that are likely to have significant effects on the future economy, environment, social welfare of communities and environment of the lower River Tana Basin and the Tana Delta in particular.

9.1 Economic Development Initiatives

Two types of regional development initiative have the potential to make major changes to the economy, social welfare and environment, not just of the River Tana basin but to the country of Kenya as a whole. The first are initiatives that are planned as part of managed national development programmes, currently represented by Vision 2030; the second are initiatives that emerge in a more spontaneous form from the political aspirations of successive administrations during their periods in office.

9.1.1 Vision 2030

Vision 2030 proposes extensive development in the River Tana Basin including the bulk of the country's future irrigation schemes, the generation of hydro-power and water supply to growing industrial, commercial and residential users throughout the north east. These are all important and worthwhile objectives but, unfortunately, a serious weakness in the formulation of Vision 2030 during the period 2000-2010 was the absence of any form of SEA or equivalent strategic assessment of the likely adverse as well as positive effects of the development strategies on social and environmental conditions.

It is recommended that:

SEA 1 A comprehensive assessment should be undertaken to establish what the cumulative impacts of individual developments is likely to be on each other and on the social, local economic and environmental conditions of areas downstream of the planned High Grand Falls Reservoir.

SEA 2 A water balance model should be prepared by Water Resources Management Authority for the lower River Tana basin which incorporates existing and future demand and builds in realistic estimates for the environmental reserve that is needed in the river floodplain between the High Grand Falls Reservoir site and the Tana Delta. A minimum river flow of 60 cubic metres per second at Garsen is needed to maintain the natural ecosystem of the Tana Delta and the ecological services it provides.

9.1.2 Individual Initiatives

Governments are inclined to launch large scale agricultural projects covering hundreds of thousands of hectares as a way of demonstrating commitment to impoverished areas without investigating all of the critical issues that can ensure success, including the availability of water, existence of markets, means of transport and training of management and labour. Examples have included the launch of the new Port of Lamu for which an EIA was provided for only the first 3 of 33 planned berths. Another recent project has involved the launch of a 440,000 ha agricultural project on the Galana/ Kulalu ranch which straddles the Athi and Tana River catchments but for which there is no public statement on the likely environmental effects. Finally, one of the projects that will have the greatest impact on the middle and lower reaches of the River Tana Basin, the High Grand Falls Dam, is reported to be accompanied by a Strategic Environmental Assessment but this document is not publicly available.

It is recommended that:

SEA 3 All government projects in the Tana River Basin involving more than 10,000 Hectares of land should be subjected to an independent strategic environmental assessment before a decision is made to confirm the project.

SEA 4 A study should be undertaken to assess the importance of communities living in the middle section of the River Tana Basin (between High Grand Falls Dam and the Primate Reserve).

This study should assess the current and future water demand in these communities and the likely impacts of the High Grand Falls Dam upon them and on further downstream users.

PART TWO
The Tana River Delta

Recommendations:

SEA 5 Charcoal burning and firewood collection threatens to destroy areas of forest and other important habitats within the Tana Delta and options for promoting alternative technologies should be explored for cooking and provision of power in rural homes.

SEA 6 Residents in the Tana Delta should be encouraged to move to settlements that can be serviced easily from the existing road network and which lie outside the floodplain. This measure is necessary in order to reduce costs of providing services to remote settlements and to improve controls over flood risk.

SEA 7 The tendency for temporary camps used by herdsmen in isolated parts of the Delta to be converted into permanent villages should be discouraged through the planning process. This measure is necessary in order to reduced pressure on the most sensitive parts of the floodplain for biodiversity and nature conservation and to minimise the number of people who live in areas that are exposed to maximum flood risk.

SEA 8 The National Land Commission should treat the Tana Delta as a special case for urgently addressing the questions of land ownership and the issuing of title deeds to residents and local communities. The biggest challenge to security in the Delta is the lack of title deeds for local residents and the historic practices whereby land has been distributed by the government to public agencies or private investors without observing legal requirements for consultation and prior notification. Inward migration into the Delta on land without legal ownership is also a source of conflict and environmental degradation.

SEA 9 The Land Use Plan should introduce an upper threshold on the number of livestock to be kept within the Tana Delta in the interests of protecting the floodplain grasslands and preventing future conflicts over competing land use.
The number of cattle that are driven into the Delta during each dry season is already above the natural carrying capacity of the grasslands, and the pressure is increasing year on year.

SEA 10 No irrigated cropping of sugarcane should be undertaken in the Tana River Delta. The SEA has shown that this type of irrigation will consume an unacceptable amount of water, thus depriving other land uses such as farming, ranching and nature conservation.

SEA 11 Factories for value addition to local produce need to be actively promoted. These to include a modern slaughterhouse to offtake excess cattle and a fruit juice processing plant to process existing and future fruit crops.

SEA 12 The Land Use Plan should place high priority on raising the standard of living for the majority of people who are living in the Delta by proposing strategies on sustainable agriculture and diversification of livelihoods. It is unacceptable that a high percentage (70%) of the population are living in poverty within the Delta and 15-20% regularly receive food aid from the Government.

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ANNEX 1

Review of Data on the River Tana Flows and Discharge in the Lower Catchment

Pre-publication draft of a paper presented to the Scientific Conference on the Tana River held in Mombasa in February 2014.

INTRODUCTION

The most recent analysis of hydrological information for the River Tana is contained in the Feasibility Study Report for the High Grand Falls Dam (HGFD) prepared by a consortium led by Egis Bceom International[1], (2011). The HGFD report and technical annexes on Climate and Hydrology make it clear that there is a serious lack of data about water resource conditions in the Lower Tana. Despite this lack of data the studies reach some important conclusions whose validity is examined in this paper. For clarity, all references to the technical studies are identified as HGFD findings, while observations in this report are noted as coming from the SEA.

FLOOD FLOWS

A large part of the Feasibility Study is taken up with investigation of flood events, since these contribute the greatest amount of water for potential storage in the proposed High Grand Falls Dam. The HGFD findings and conclusions are summarised in a Summary Report, from which the following extract (Box 1) is taken.

This SEA review fully supports the basic statements in the HGFD (Box 1 above) about the lack of adequate data (1) and the need for an integrated assessment of conditions in the Lower Tana (v). However, the SEA considers that observations (ii) and (iii) conflict with empirical and anecdotal evidence from the Delta. The HGFD findings are also contradicted by the output of a new water balance and hydrological modelling study for the lower delta (Leauthaud *et al*. 2013).

The HGFD Consultants' conclusions that outflows from the Upper Catchment of the River Tana do not contribute to any significant extent to floods in the Tana Delta are based on studies of the flood hydrographs which show very large and acute peaks for upstream locations (Masinga; Grand Falls), intermediate flood flows for Garissa and virtually a flat curve for Garsen. (See examples in **Box 2** of figures extracted from Annex A to the HGFD Main Report).

The flood events described in the HGFD Feasibility Study typically have a duration of one to two months, and the analysis presented in that study focuses entirely on these events. There is very little discussion of what conditions are like during the remaining months of the year. However, the appendices to Annex A (HGFD) do include annual summary tables of mean monthly discharge at various points in the Tana Basin.

This data on mean monthly flows (at the Masinga dam, HGFD site, and Garissa, Hola and Garsen gauges) has been processed for the SEA and shows that the

BOX 1 FLOOD ANALYSIS (HGFD)

The study also considered the main past floods, main source of floods and their propagation, flood frequency analysis, effects of artificial floods release from existing dams, and the expected impact of HGF on flooding. The main conclusions were:

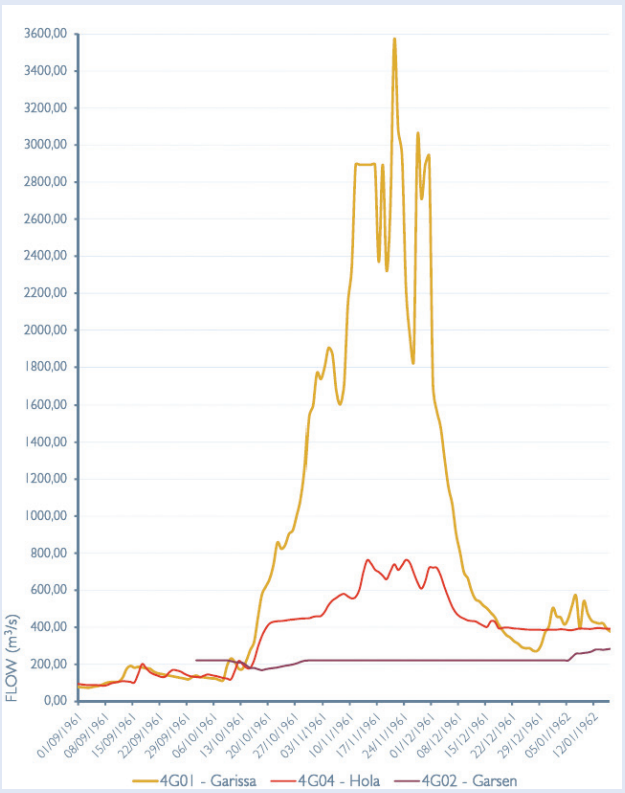
1. Flows at Grand Falls contribute floods mainly only up to Garissa. Below Garissa, it is impossible to determine the actual flood flow from tributaries downstream of Grand Falls and upstream of Garissa, due to lack of data.
2. Most of the flood flow from the upper catchments is lost due to evaporation, flooding and seepage downstream of Grand Falls, and only a little amount reaches the Tana Delta.
3. The HGF dam will have negligible effect on the control of natural floods in the delta, as existing dams in the upper catchment already perform this function. Moreover, as seen in (ii) above, the source of most of the flood flow in the delta lies downstream of HGF dam.
4. The dam will be designed to release artificial floods twice a year, thereby regulating the flood downstream of Garissa.
5. However, before the optimum artificial flood is defined, comprehensive information is required on the environmental and socio-economic factors at play downstream of HGF. Therefore, an integrated and overall assessment of these factors must be done before dam construction begins.

[1]High Grand Falls Multi-Purpose Development Project; Feasibility Study, February 2011

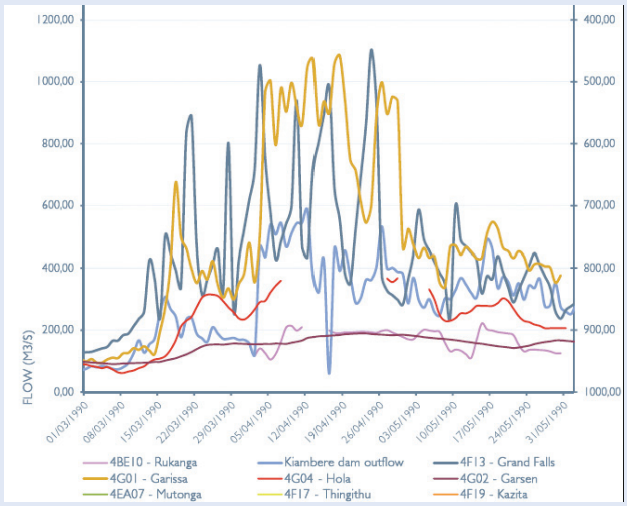
variability in flow conditions at Garsen responds in a remarkably similar fashion to the upstream gauging stations, although with a much subdued amplitude (See Figures 1 and 2 below). Figure 1 below shows annual plots for the six successive years at Garsen between 1959 and 1965, while Figure 2 shows the same information for the later period of 1990-95.

Figures 1 and 2 are based on data for two separate periods for which an almost complete data set is available for the Garsen river gauge. These are the years 1959-65 and 1990-95. The first set of records covers a period of 72 months and has only 3 missing months which can be extrapolated. The second set of records has 5 missing months out of a total of 72 months.

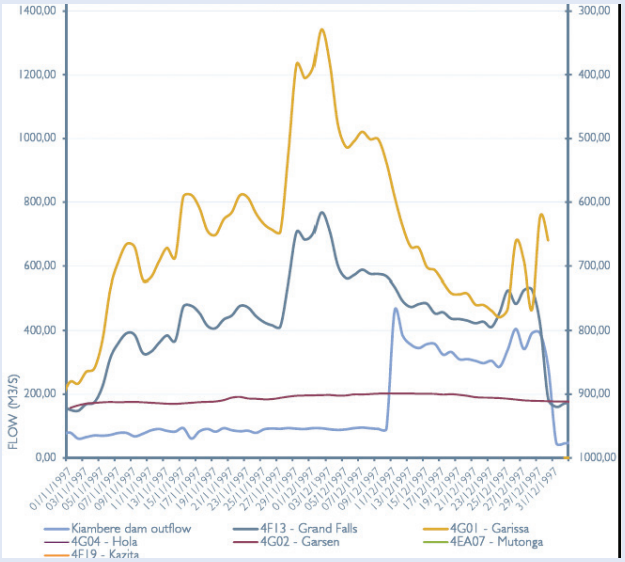
BOX 2: EXTRACTS OF FLOOD HYDROGRAPHS FROM ANNEX A - CLIMATE AND HYDROLOGY (HGFD FEASIBILITY STUDY)



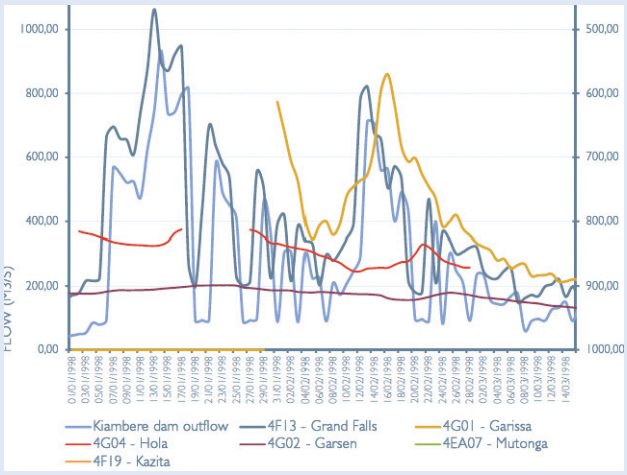
October to December 1961



March to May 1990



November to December 1997 (El Nino Event)



January to March 1998 (El Nino Event)

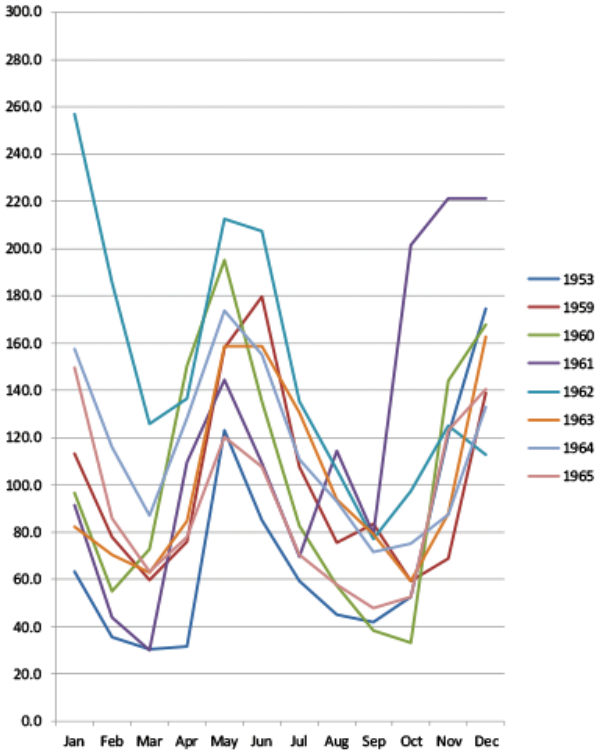


Figure 1: Mean Monthly Discharge in M³/sec at Garsen (1959 - 1965)

Conveniently, the first period (1959-65) predates the impact of upstream dams (which were only built between 1966 and 1988) while the second follows completion of the Masinga Dam.

The periods for which data are available are too short to allow a statistical comparison to be made, but the graphs support the well-established view that there is less variability in the flood flows at Garsen following construction of the upper cascade of dams, especially in the pattern of releases in the lower limb of the hydrographs for the short rains in April and May. There are also no flood events above 180 m³/sec at this time of year compared with three which exceeded this value in the 1959-65 period. In general, the variability in monthly mean flows is less pronounced during the second period than the first, as would be expected as a result of river regulation.

In **Figure 3**, mean monthly flows are aggregated to produce an average flow at Garsen for each month during the two time periods. Flows during the long rains (December – February) are a little higher in the earlier period (59-65) than in the later period (90-95) indicating, perhaps, that dam construction had the effect of reducing flood runoff during the main flood events. On the other hand, all other months see a reduction in discharge.

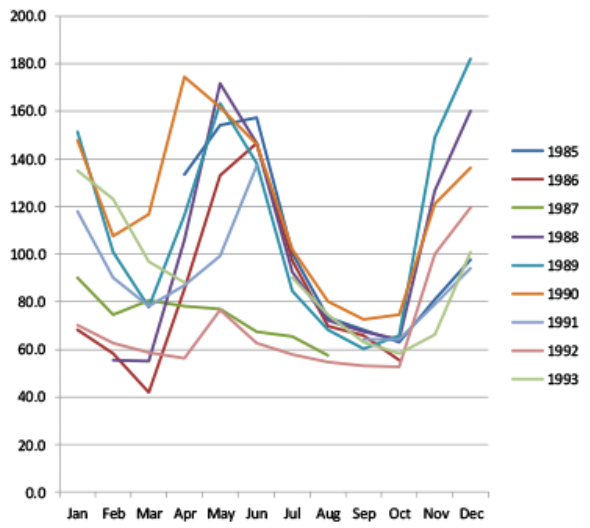


Figure 2: Mean Monthly Discharge in M³/sec at Garsen (1988 - 1993)

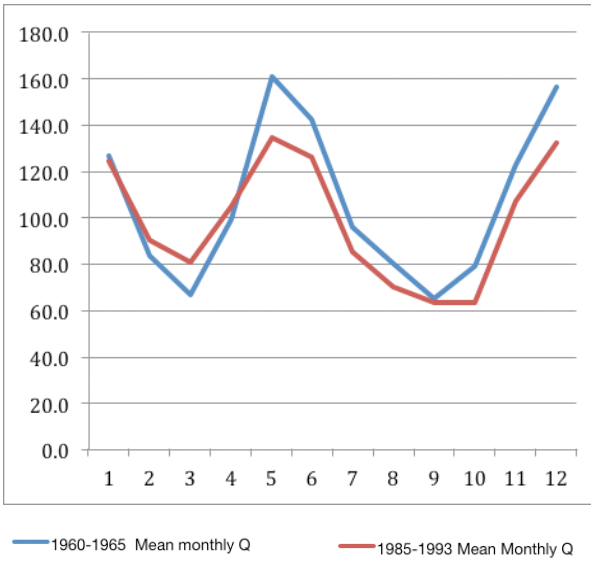


Figure 3: Mean Monthly Discharge in M³/sec at Garsen in 1960-65 and 1985-1993

The mean monthly flows at Garsen have been plotted as a continuous record for the two periods (see **Figure 3**) which highlights the twin annual flood events for the years in question and indicates that there are marked changes in the flow regime of the River Tana as it enters the lower delta over the course of the year. This fluctuation may not be as pronounced as the pattern which occurs upstream but when the same data is added for the High Grand Falls and Garissa gauges (see **Figure 4**) there is a remarkably close fit in terms of the falling limb of the hydrograph in the months of June-October with a fairly narrow band of lower discharge rates from 60-150 M³/sec. It is also apparent that flow conditions at Garsen respond to the onset of rainy seasons roughly one month behind the upper river.

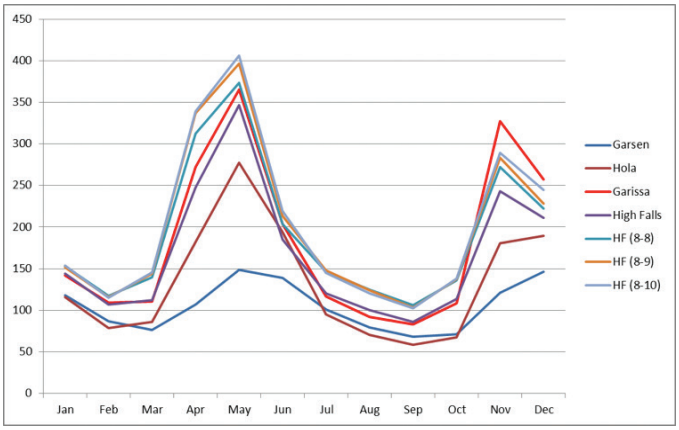


Figure 4: Comparison of Mean Monthly Discharge (M^3/Sec) at Garsen and Upstream Sites for seven years of continuous records (1959-1965)

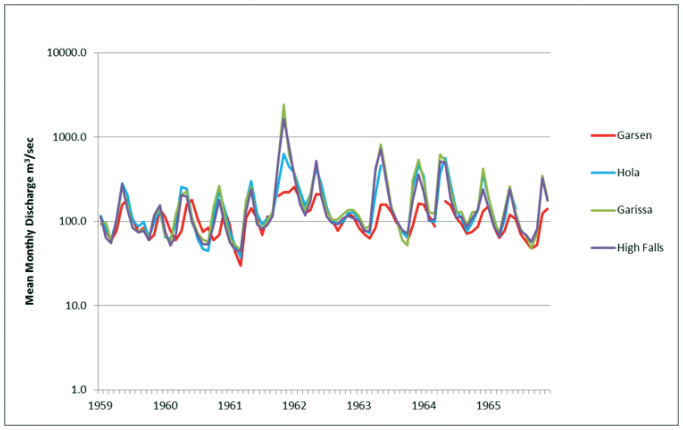


Figure 5: Data for Mean Monthly Discharge Presented on Logarithmic Scale

Use of a logarithmic scale in Figure 5 focuses attention on the 'normal' discharge rates in the range of 45-145 m^3/sec and reduces the dominance of peak flood flows. It highlights the fact that the base flow in the River Tana at the four gauging points remains remarkably consistent, except in flood events.

The key observation that can be made from the information presented above is that the flow conditions at Garsen vary considerably throughout the year and are clearly responding to upstream conditions, which is largely generated by the main river flow since added discharge from lagas entering the flood plain below Garissa only occurs during the short and long rains.

In order to explain this phenomenon it is hypothesised that flood flows in the upper catchment, above the Grand Falls, are transported rapidly, as in-channel flow, with very little to impede progress other than the dams themselves which only serve to impound water in the early stages of a flood. Once the dams are full, the full flood spills over and continues downstream.

Below the Grand Falls rapids, the river morphology changes from a torrent tract to a wide floodplain with extensive marshes and wetlands. Consequently the effects of the flood are attenuated as water spreads over the entire corridor which is 6-8 kilometres wide. This moderates the peak flow, while water continues to move towards the sea in the form of both surface and sub-surface flow. The result is that by the time water reaches the Garsen Gauge at Idsowe Bridge, the flow pattern has been attenuated but there is still marked periods of peak and low flows which lag up to a month behind the upstream regime.

ENVIRONMENTAL FLOWS

Understanding environmental flows or the 'environmental reserve' is critical to future planning of water resources in the Tana Basin and especially the safeguarding of the Tana Delta. Work undertaken to date by engineers and scientists working on the feasibility studies for the High Grand Falls Dam has focused on the amount of water needed in a river channel to sustain aquatic life as presented in Box 2.

BOX 2 ENVIRONMENTAL FLOWS

The consultants also considered the need to ensure that HGF dam would ensure that environmental flow in the River Tana is maintained. This is the minimum flow required to maintain life for aquatic and terrestrial species in the lower catchment, as well as for the conservation of livelihoods in general. This requires a complete environmental and social study of the lower catchment, which was not done as, it was not in the framework of the feasibility study and in any case, there did not exist adequate data to undertake an analysis of that scope.

It was therefore not possible to estimate the environmental flow for the Tana Delta. Using water balance simulations and by considering the 95% exceedence flow, the consultants estimated the environmental flow between Grand Falls and the delta as 10 – 30m^3/s. However, the actual value can only be determined once river losses and existing water abstractions from the lower catchment are known. The problem with estimation is that there lies the possibility of both under-estimating or over-estimating river losses and environmental flows. The first scenario would mean that there is less water for irrigation and water supply, thereby affecting development and livelihoods. Over-estimation would mean that there is more water for water supply, power generation and downstream development.

The approach outlined in Box 2 is valid where most of the water flow occurs within the river channel and water only spreads across the flood plain during peak river flows. However, research for the SEA has shown that flows in the Tana River have historically maintained a minimum monthly mean of 60m^3/second at Garsen (Idsowe Bridge), with levels dropping to 45 or 30m^3/second in only a few months in extreme drought years.

Once the river reaches its divide between the former main channel and the Matomba Brook the bulk of the discharge (perhaps 60%) is diverted into the eastern arm where it is dispersed through a myriad of small brooks and channels, often less than half a metre in depth and a few metres wide. These channels spread out in depressions to form marshes, swamps and very shallow lakes with only a few centimetres of standing water. The entire delta area is therefore acting as a part of the hydrological system and during dry seasons it is the dispersal of water across the entire floodplain which maintains high soil moisture levels and supports the delta ecosystem.

A rapid assessment has been made of the effects of evapotranspiration rates of 100 mm /m^2 per month from 90,000 ha of wet grassland in tropical conditions, with temperatures remaining above 250 centigrade and clear skies. This suggests that the gross water demand for vegetation in the delta during a drought of 4-6 months duration, is the equivalent of a river discharge rate of 35 m^3/sec. This figure makes no allowance for other water uses including livestock, human consumption, navigation, agriculture or the development of local irrigation schemes.

CONCLUSION

The conclusion drawn from this preliminary assessment is that the suggested environmental reserve flow of 10-30m^3/sec is a serious underestimate of the delta's existing needs and, with continuing population growth and the aim of restoring the delta's biodiversity to an acceptable standard, the minimum flow in the River Tana at Garsen (Idsowe Bridge) should be set at the mean rate of 60m^3/sec.

15 November 2013