Developing environmental indicators as a tool for effective management of wetlands:

Tana River Delta and Floodplain

REPORT PREPARED BY THANDIWE CHIKOMO

FUNDED BY:

The Ruffords Small Grants Foundation
www.ruffordsmallgrants.org

COLLABORATORS:

Tana River Conservation Organisation-TADECO
Nature Kenya
Kenya WildLife Service
BirdLife International- Africa Partnership Secretariat
University of Nairobi

31 NOVEMBER 2011

TABLE OF CONTENTS

CHAPTER 1: INTRODUCTION

1.1 Introduction

Kenya is one of the least forested countries in sub-Saharan Africa with forests covering only 37.6 million ha - about three per cent of total land area, yet decimation of the forests continues unabated as exemplified between 1990 and 2005, when Kenya's proportion of forested land decreased by 0.3 per cent. At the same time, wetland ecosystems which sustain almost a quarter of all birdlife in the country have rapidly dwindled through replacement by human settlements and agriculture. Most wetlands are threatened also through overuse due to unsustainable extraction of consumptive natural resources and misuse including waste dumping. Degradation of wetland ecosystems and their biodiversity especially birdlife is likely to affect important socio-economic obligations in Kenya especially the realization of Vision 2030.

There is need therefore for increased efforts to protect wetlands in Kenya through better management and with greater involvement of the local communities who are the ultimate custodians of such critical environments. The key problem for the proposed research is to attempt a domestication of the CBD's biodiversity indicator at the local level by establishing the kind of indicators which can originate from grassroots local communities in wetland IBAs of Kenya and assess their viability in wetland management policy decision making and planning activities.

Due to the unprecedented crisis emerging from the loss of biodiversity, the importance of *biodiversity conservation* is now recognised at the global level (WCED 1987; Wilson 1988; IUCN *et al.* 1991). As recognition for the special value of biodiversity for society, the Convention on Biological Diversity (CBD) was adopted in 1991.

In 2002, the Sixth Conference of the Parties to the Convention (COP6) agreed "to achieve, by 2010, a significant reduction of the current rate of biodiversity loss". To assess progress towards that target, COP6 adopted a framework to guide the biodiversity management actions and recognized the need to identify biodiversity indicators for assessing the status and trends of biodiversity. Environmental indicators have been defined in different ways, but the common themes exist. 'An indicator is a sign or signal that relays a complex message, potentially from numerous sources in a simplified and useful manner' (Jackson *et al.*2000). 'A parameter or a value derived from parameters that describe the state of environment and its impact on human beings, ecosystems and materials, the pressures on the environment, the driving forces and the responses steering that system. An indicator has gone through a selection and/or aggregation process to enable it to steer action' (EPA Environmental Indicators Gateway, USEPA 2010).

The indicators developed at the local scale have the potential to serve as an early warning system for future biodiversity change. The study acknowledges that for indicators to be effective they need to be monitored. This is however much easier said than done, especially in biodiversity rich but poor developing countries of Africa. Walpole *et.al* (2010) comment on the "patchy" global data that exists for biodiversity monitoring and calculations, and the need for both global and national data monitoring and capacity building in the area of biodiversity

measurement. Even the developed countries have had their own unique challenges with data sets. For Africa in particular, this is because resources- both financial and human to be able to cover the broad areas that are usually far apart are extremely limited. Indeed some efforts are ongoing in Kenya and other parts of Africa by building capacity- however there is need to increase resources towards data collection and monitoring. Biodiversity data is currently scarce and the protocols to share data have not been fully developed and agreed upon. However, if developed by the local communities for use by the local communities for site level management, the complexities of inaccessible/incomplete data sets does not preclude/disqualify the attempts to analyse the linkages between biodiversity indicators, ecosystem services and local livelihoods.

In this context, this study therefore seeks to contribute to a site level focus where biodiversity is most in danger due to the escalating, intense and diverse pressures that are compounded by inappropriate policy decisions and where the effects on human livelihoods are and will continue to be most keenly felt. Due to the inextricable link between biodiversity and people, observations can be made at the local scale and the local people must be given a platform to inform policy decisions, the starting point is that issues should also be looked at from their point of view- at the local level. Some important changes in biodiversity can only be detected at the local scale. Several authors have also acknowledged that there is a marked difference in the way local people and the outsiders 'intellectuals' conceptualise environmental issues. The scientists have an understanding and conceptualization of macro- level, global issues, while the local person has an understanding of issues limited to the local surrounding.

1.2 Statement of a Research Problem

Most decisions on how to reduce biodiversity loss have largely been based on biophysical and economical assessments, with little consideration for the local people's knowledge, opinions or perspectives and this is a major problem. The genesis of the problem can be traced to the nature of standard biological survey methods, which are not well designed to 'capture' local and environmental issues in a way that is useful for decision makers. This has alienated local communities and the situation can lead to conflicts over natural resources management, unsustainable land use and decisions that are unfair to local people. The magnitude of the problem is so serious that some authors have stated that the indicators developed so far 'are the best kept secret of the world' as they are hardly known by users. Hence the indicators are unfamiliar, difficult to understand, unsuitable to local needs and irrelevant to policy instruments.

The situation is exacerbated by the fact that biodiversity management and decision making in most countries of the world is controlled by the government as the overall manager and custodian of the environment, to the exclusion of the local community. Noting that local perceptions of the communities usual differ from government planners, policy makers and the scientific perspectives, it is imperative to engage the local communities. Systematic assessments of local perceptions can enable us to capture the values and concerns of the local people and take them into account in any wetland management decision making. The study will make an attempt to analyse and describe the current state of biodiversity from the side of the local people, without professing that this represents 'all' local people's perspective. It provides a platform for the local communities to suggest indicators to maintain and sustain biological diversity. The study will be cognisant of the fact that cultural differences of the people in the

selected sites may affect their perception about biodiversity. The areas could differ by area according to environmental conditions and people's activities. Max- Neef et al (1998(in Pimbert and Pretty (1995) state that while fundamental human needs are universal, their 'satisfiers' vary according to culture, region and historical conditions. In developing these indicators, the study will not overlook some of the spiritual, emotional or aesthetic significance of a diverse natural system. The study will take as its starting point, the existing status of wetlands biodiversity from the perspective of the local community, which can be defined in terms of their resource base – physical, natural, human, social and economic – the capital assets of the system.

Some of the burning research questions to be considered in the research include the following:-

- What is the perceived state of environment in the wetland IBAs of Kenya in the minds of the local people and how do they, for example, visualize their deteriorating biodiversity trend and likely impacts?
- What kind of threats are facing biodiversity at the local scale and what are the response action being undertaken
- What kind of pressure, state and response (PSR) indicators are envisaged by the local people, how would the local communities monitor those indicators and how do these indicators compare with those from the technocratic and scientific arena?

1.3 The Goal and Objectives of the Study

The overall goal and purpose of the research is to assess local perceptions on biodiversity for the purposes of developing environmental indicators for effective management of selected wetland Important Bird Areas (IBAs) in Kenya.
The specific objectives are to:-

1. Analyze and document the current state of environment (SoE) for the selected wetland IBAs sites.
2. Predict the future changes of the environment and the impacts of climate from the local knowledge and community perspective.
3. Develop suitable community-based Pressure-State-Response (PSR) indicators that are amenable to practical implementation at the local level.

1.4 Justification of Research

The academic value of the study has a potential to benefit various targets. First and foremost, the researcher will benefit as a doctoral candidate as this research is a one of the key components of a broader academic progamme which will provide the basis for a doctoral dissertation -PhD Degree in Environment. Once complete, the study will advance the researchers academic and career pursuits. Beyond a personal level, the study has a potential of enriching the intellectual discourse on biodiversity indicators in Africa.

The topic is also worth being investigated because concepts of biodiversity in general and biodiversity indicators in particular are new (Bubb et al. 2005). The subject under study is topical, likely to continue in the future and there is evidence and authoritative opinion to support the need for the development of indicators. Given the magnitude of the environmental

problems, the CBD has repeatedly emphasized the importance of developing national biodiversity indicators and building capacity for their further development and use. In 2002, world leaders committed, through the Convention on Biological Diversity, to achieve a significant reduction in the rate of biodiversity loss by 2010. To that end, a team of experts compiled 31 indicators to report on progress toward this global target. Despite some local successes and increasing responses (including extent and biodiversity coverage of protected areas, sustainable forest management, policy responses to invasive alien species, and biodiversity-related aid), the rate of biodiversity loss does not appear to be slowing (Butchart et.al (2010). As already indicated above, Kenya has also been facing a plethora of environmental challenges which continue unabated, negatively impacting on the millions of people dependent on the resources and the livelihoods of the future generation.

Therefore the indicators identified should be amenable to practical implementation at the local level, with the potential of influencing policy decisions as well as informing biodiversity planning and management at the local levels particularly in the case of District Environment Management Plans (DEAPs), District Strategic Plans, site specific management plans and Community Action Plans (CAPs).

The study fits in well with the Ramsar's theme for 2010 on 'Caring for Wetlands - An Answer to Climate Change' in response to the expected impacts of climate change on wetlands, birdlife and society. The study also fits in well with the mandate of UNEP, especially in the Division of Environment, Information and Assessment whose mandate is to 'keep under review the state of environment; enhance understanding of critical linkages between environment and human activities; identify priorities for international action; flag emerging issues and strengthen national, regional and global information handling'. Moreover, the subject is researchable, feasible, and ethical.

It is also worth investigating issues in areas internationally recognized as Important Bird Areas (IBAs) because birds have a real connection with people and their lives. Birds can reflect trends in other animals and plants and can be sensitive to environmental change.

CHAPTER 2: REVIEW OF THE LITERATURE

2.1 The steps for defining appropriate indicators and a review of biodiversity indicator initiatives at the regional and national levels

Environmental indicators may be developed at many levels and by a range of stakeholders. Environmental Indicators can be measured and reported at different scales. National governments use environmental indicators to show status and trends with respect to environmental issues of importance to their citizens. The indicators should be selected /developed partially based on who will be using the information from the indicators. Each of the audiences have different needs and they can range from technical and scientific experts/advisors, policy makers and resource managers and the general public and media. For indicators to be effective at a general level they must meet a number of competing scientific and practical criteria. These include qualities such as scientific credibility, sensitivity to environmental change, links to drivers, clarity of message, affordability and ease of update (Landres *et al*. 1988; Bibby 1999; Caro & O'Doherty 1999; ten Brink 2003; Gregory *et al*. 2003; SBSTTA 2003). Technical experts and scientists will be interested in detailed and complex indicators i.e. scientific validity, responsiveness and have data available on past conditions. The policy makers/resource managers will be concerned with using indicators that are directly evaluating policies and objectives. Although they also require the indicators to be sensitive and responsive and historical data available, they are also looking for indicators that are cost effective and have meaning for public awareness. The general public responds to indicators that have clear and simple messages and are meaningful to them.

Over the years, conventional development indicators have been developed mostly within the PSR framework which is explicitly recognized by the CBD (CBD, 1997a). Biodiversity, despite its apparently clear cut scientific definition (McNeely et al 1990) is impossible to measure as a whole. Because the definition includes processes or interactions between the components and also because other less definable emergent properties, the whole is more than the sum of the parts and the indicators will always overlook some of the spiritual, emotional or aesthetic significance of a diverse natural system (European Tropical Forest Research Network). Furthermore, the logistical challenges of including all components and the subjective nature of observation ensure that any biodiversity assessment by scientists and other includes some subset of all biodiversity. Decisions must therefore be made about which components are to be measured and what they tell us about the whole (or part of that we are interested in). The choice of indicators must therefore be made by or interesting to the local stakeholders and must also have a clear relationship to the whole.

Literature shows that most of the environmental indicators developed around the world are externally oriented, in their value system. Most of them assumed that local people had no perceptions of their own. The indicators were also 'simplistic' about biodiversity management and generally silent about environmental dimensions and yet the state of environment, especially state of ecosystem health, is the mainstay of biodiversity.

Moreover, defining the indicators only in scientific language has not helped. The trouble with normal science is that it gives credibility to opinion when it is defined in scientific language, which may be inadequate for describing complex changing experiences of rural people and

other actors in conservation and development. As a result, it has alienated many of these local communities. There is a need to advocate for biodiversity conservation by relating it to people's everyday lives, and to the consequences of inaction. The local communities should therefore be allowed to make an important contribution to the development of indicators because they have a concern about the environment and can contribute significantly to the efforts to manage the environment on a sustainable basis.

Schreckenberg K et al (2010) argue that the some indicators are more suited to particular timescales while others work well at certain geographic scales or provide data suited to specific target groups. Herweg et al, 2006 inSchreckenberg K et al (2010) discuss both qualitative and quantitative indicators and highlight that they can be defined in terms of 'external' and 'internal'. Internal indicators are created by local stakeholders, according to their own objectives and measurements and vary from place to place. Holland and Campbell (2005) therefore conclude that internal indicators are part of a more 'contextual' and often participatory methodological approach. They argue that this provides an opportunity to explore issues within one locality in depth. On the other hand externally defined indicators are based on pre-defined and external views and agreements, without consulting the local communities (Herweg et al, 2006 in Schreckenberg K et al 2010).

For most of the indicators that they assessed, Schreckenberg K et al (2010) note that these were largely qualitatively in nature and they argue that these are more difficult to aggregate and represent at higher levels. They advocate that more thought is required to ensure that the social and cultural issues can be effectively communicated to decision makers.

With regards to methodologies for defining indicators, Schreckenberg K et al (2010) indicate that many authors do not explain the process of defining indicators, especially where external indicators are concerned. Guidance is however provided in internally defined indicators (Sayer et al, 2007; Catley et al, 2008 and Bunce and Pomeroy, 2003). The 2010 Biodiversity Indicators Partnership is a very useful source of advice on defining indicators. BIP 2008 identifies a number of steps. Among these are the need to determine the key end users and the kind of indicators they need, indicators can focus on those connections between protected areas and livelihoods that are strongest and most relevant for communities. This requires developing criteria for identifying communities who depend on the protected areas. The criteria stated by BIP 2008 are as follows: absolutely dependent, sustenance dependent, partially sustenance dependent, economically dependent and psychologically dependent and then devising a weighting system based on the level of dependence (BIP 2008). There is also need to indicate the indicators for negative impacts defined as 'killer indicators'. These can be useful in ensuring a 'rethink' in terms of approaches. Resource availability is a determining factor in gathering indicators. The United Nations Conference on Environment and Development (UNCED) in 1992 recognized the need to develop indicators to enable countries to make informed decisions regarding sustainable development (Chapter 40 of Agenda 21).

During the decade following UNCED, many initiatives, including an initiative of the UN Commission on Sustainable Development, have sought to identify indicators of sustainable development. Noting that human activities have numerous and wide ranging consequences, a PSR conceptual framework to structure diverse environmental information and make it more accessible and intelligible to decision makers and the general public was produced. A successful

and innovative PSR Framework was developed by the Organization for Economic Co-operation and Development (OECD). The PSR framework has been widely applied to indicator development; for example, it is explicitly recognized by the CBD (CBD, 1997a), used by several OECD member countries including the Netherlands (Adriaanse 1993) and the U.S (EPA 1996a). The PSR Framework is also used by organizations such as BirdLife International, The Nature Conservancy, WWF-U.S., the Biodiversity Support, Programme, and Foundations of Success. One of the advantages of this framework is that it can reveal data gaps, thus guiding data collection efforts. Indeed, PSR indicator system provides a useful and simple tool to formalize environmental problems due to its intuitive structure – human pressure on environmental state and political responses to adopt solutions. Environmental scientific programs have also adopted the PSR framework for developing interaction indicators.

Since the publication of the first OECD report regarding PSR indicators, some criticisms have highlighted the theoretical limits of this framework (OECD 1994; Hukkinen 2003b; Wolfslehner and Vacik 2007). In particular, the challenges associated with establishing cause-effect relationships between the three boxes and the PSR framework suggests an over-simplified representation of the complex social-ecological interactions and structures.

According to Levrel et al (2009) there are few papers which propose an empirical assessment of such indicators on the ground. They assert that working groups that have developed PSR indicators in a specific field have mainly focused on underlining the limits of this framework without going further into their analysis. In particular, the key question of how it is possible to use PSR framework as an operational tool for managing social-ecological interactions is poorly discussed. Accordingly, they identified traditional indicators of pressure, state and response in the field of biodiversity management and gathered some empirical evidence in order to appreciate their relevance for park managers.

Modifications and adaptations of the PSR framework also arose as some practitioners found the framework inadequate for capturing what is happening at their sites (Briassoulis 2001; CSD 2001; Zaccaï 2002; Hukkinen 2003a).The Driver-Pressure-State-Impact-Response indicators (DPSIR) (European Environmental Agency 2003, EEA, 1998, Rigby et al., 2000).), the Driving Force-State-Response indicators (DSR) (Commission on Sustainable Development 2001), the Pressure-State-Use-Response-Capacity (PSURC) (Convention on Biological Diversity 2003) all come from the OECD's original framework.

The Biodiversity Indicators for National Use (BINU) project, which was supported by GEF in 1992, aimed to learn about the potential and methods for the development of biodiversity indicators at the national level. The project supported national partners in four countries, one of them being Kenya, to develop and test several indicators for a single focal ecosystem, using an iterative process of consultation, inventory and synthesis of existing data. UNEP-WCMC co-ordinated the project and provided technical support in conjunction with RIVM (now the Netherlands Environmental Assessment Agency – PBL). The stakeholders that were involved are: Kenya WildLife Service in collaboration with National Museums of Kenya, Kenya Marine Research Institute, Department of Fisheries, Ministry of Planning and four national universities.

The methods and experience from the BINU project have been vital in laying the foundations for the 2010 BIP's regional/national biodiversity indicator capacity building work. Kenya formed

four task forces to focus on each of the main wetland types in the country. Each task force targeted their work around four focal sites: Lake Naivasha (freshwater lakes), Lake Nakuru (saline-alkaline lakes), Tana River (riverine wetland), and Yala Swamp (swamps).

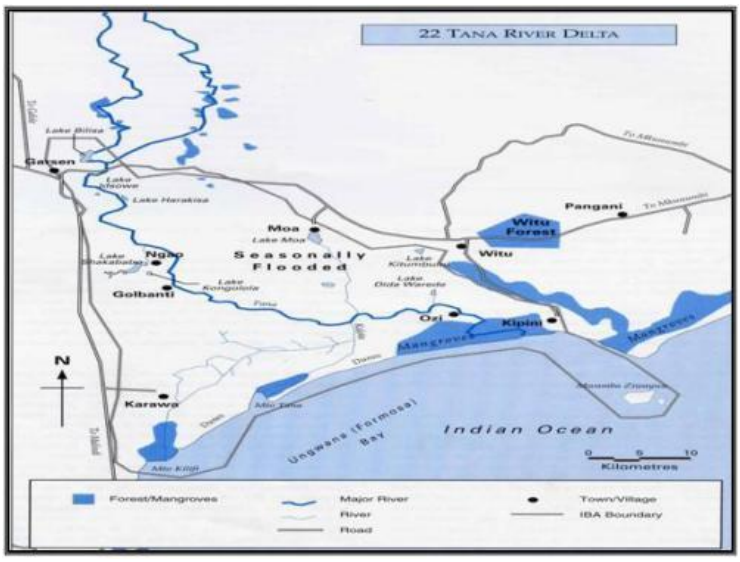
CHAPTER 3: DESCRIPTION OF STUDY SITE

As in many wetlands in developing countries, the selected wetland IBA for this study has a discrete community depending upon their various products and services. Thus the biological importance of these sites and the human population and land use around these wetland IBAs will be looked at in this section.

The delta is roughly triangular in shape, with its apex at Lake Bilisa (north of Garsen) and its base a 50 km stretch of beach along Ungwana (or Formosa) Bay, stretching from Kipini in the north-east to Mto Kilifi in the south-west. This low-lying area is bounded by higher land to the east and west and to the south by a dune system bordering the Indian Ocean. It forms the interface between the river and the ocean, with fresh and brackish lakes and streams, freshwater and saline grasslands and wetlands, and succession stages of forest and woodland on the riverbanks and the dune ridges parallel to the shore (Robertson & Luke 1993).

The Tana River basin is characterized by high diversity of habitat types including riverine forests, grasslands, woodlands, bush lands, lakes, open river channels, sand dunes, mangroves and coastal waters among others. This high diversity of habitat types is associated with correspondingly high biological diversity (biodiversity) of both flora and fauna. The river floodplains and their associated mosaics of riverine forest patches is particularly important as a habitat for threatened and endangered species like the Tana River Red Columbus, Tana River Crested Mangabey, elephant, fish and plants. The riverine wetlands are also important ecosystem that acts as a staging, resting, nesting and feeding ground for resident and migratory water birds.

Due to its biological importance, Tana River is an important life sustenance system that provides resources and services used to meet local people's livelihoods. Different communities including farmers, fishermen, pastoralists and semi-pastoralists utilize the river floodplain for their livelihoods. The ethnic groups comprise of the Orma and Pokomo (pasturalists and agriculturists) and the Luo and Luhya (fishing). The indigenous communities of the river basin have practiced traditional land use activities for thousands of years without major impacts on the environment. The study focused on the riparian community in Kipini, Ozi Village (both Kipini villages perch on a section of the river that widens into a delta, before it finally empties into the Indian Ocean/ floodplain village of Dida Waride and the Moa village which is closely located near the Lake Moa bow lake.



Source: Fishpool and Evans (2001)

CHAPTER 4: METHDOLOGY

4.1 Techniques of data collection

The methods used for data collection included participatory and conventional methods. The first step taken was to establish contact with the local leadership of the areas of study. Several meetings were held to present the objectives of the study. These were followed by meetings and coordination work with community representatives to establish a common agenda, merging initial research proposed and local interests, based on the establishment of common interests.

Focus group discussions with specific resource users (water resource users, fishermen, livestock herders/owners, herbalists, forest users, bee-keepers, farmers etc) to determine the quality as well as quantity/abundance of species, species diversity, species density as well as the ecosystem services provided. Focus Group discussions were done by bringing several participants into a setting for a guided interview that is intended to explore a particular topic of interest related to a resource. The size of the group was small enough to allow everyone to express a viewpoint and large enough to capture a diverse range of perspectives. The groups focus on at least 7 to 12 people and lasted not more than 2hrs. Multiple sessions were conducted to ensure enough opinions to identify patterns and themes in the participants' comments were gathered. Selecting focus group participants who shared certain characteristics fostered an environment that encouraged participants to interact among themselves during the focus group sessions.

Topical semi- structured interview were carried out. The interviews were based on pre- designed questions, but they were presented in an informal, discursive way to establish greater trust, dialogue and increase opportunities for locally relevant information to emerge. The questions were focused on; how nature used to be, how nature is at present and what the desirable state is, rainfall patterns, diversity and density of resources, changes in wetlands and the environmental challenges faced, implications of climate change, patterns of resource use.

Workshop- pre- designed and nurtured by collaborating with the leadership of the community and the representatives of local conservation organizations working with the local communities. The workshop presented a space to start a process of information exchange between local people and the research team. The local community had an opportunity at discussing challenges and considering different solutions in a collaborative manner.

'Oral history' was a tool used to enable gathering of historical information through recorded interviews of people about past events and ways of life and also to capture how they expressed themselves about their biodiversity. Oral history was obtained through one-on-one interviews, wherein the researcher observed, listened and evaluated the interviewers.

Key informant interviews with individuals that have a broad knowledge of the community, its services, and its people, for example the long term serving traditional leaders and the local environmental activists. Key informant interviews were conducted with personnel/practitioners from the relevant institutions, District Local Authorities, BirdLife International, Nature Kenya

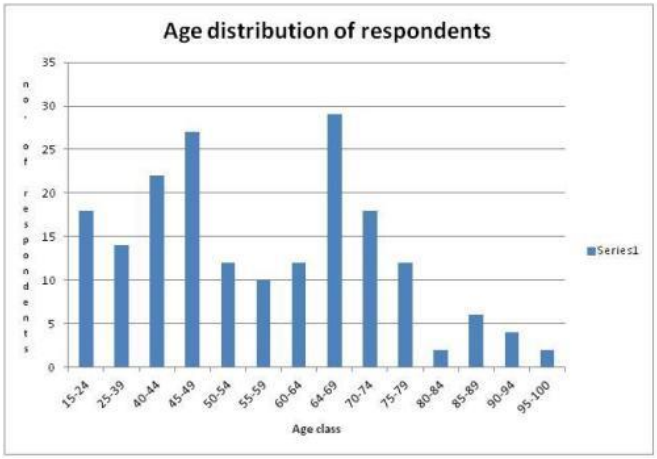
Household interviews; the head of the household was the main interviewee. In cases, where spouses were willing to participate in the interview they were both interviewed together. At times, the youth (between the ages of 15-17) belonging to some of the households were also called in to participate in the discussions and to give their views. Due to a lack of a suitable sampling frame, purposive sampling was done, whereby the leader of the community or the Chair of the resource user group i.e. irrigation/agriculturalists/farmers, pastoralists, fisheries and forest users was asked to give the names of at least 4 resource users in each category in their respective village. A total of 4 villages were covered in the Tana Delta- Kipini, Ozi, Dida Waride and Moa. In terms of ethnic groups, the study was able to interview the Pokomo, Orma and the Wardei and the Luo.

Transact walks- Random interviews were also conducted with fishermen, pastoralists and farmers and different resource users especially during the transact walks.

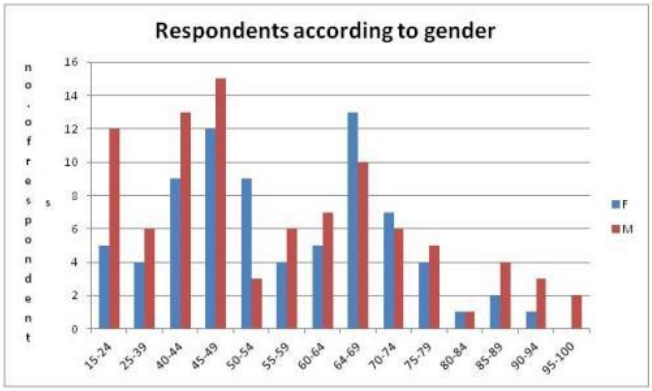
In order to ensure that the study was conducted in the most ethical manner- meetings were held with the local community to explain the objectives of the study before starting the field work, and requests for their participation as well as seek their mandate to conduct the study. The study endeavored to respect indigenous intellectual property rights as well observing the culture of the local community. An effort was made to ensure that community's decisions were respected and that the study did not challenge existing systems but rather be seen as adding value to conservation and development in the selected areas. A triangulation of methods as stated above were useful in ensuring that unbiased and reliable data was collected.

In terms of logistics- local guides, translators and enumerators were trained to facilitate household/ground level interviews. It was essential to have local translators fluent in the indigenous languages as some of the older respondents were not be fully conversant with either Kiswahili or English. Involvement of the local researchers enhanced the connection with the local communities participating in the study. Community ownership of the results of the study was also enhanced. While conducting the field and conducting interviews photographs were taken- in cases where individual were photographed their permission was sought, detailed written notes were taken as well as audio recording to enable re- visiting for clarification if necessary.

The following villages were selected: Tana River Delta: Kipini, Ozi, Dida Waride and Moa. Failure to obtain the most up to date data on the size of the population and the number of households in these study areas made it difficult to calculate an appropriate sample size of respondents. However, in total, 169 respondents were interviewed. The breakdown is as follows: Kipini (52); Ozi (48); Dida Waride (27) and Moa (42). The participants comprised of agricultural farmers, livestock owners/livestock herders/pastoralists/coastal and inland fishermen, traditional healers, mangrove harvesters, reed harvesters, papyrus harvesters, carpenters, bee-keepers and charcoal producers.



The largest number of respondents was drawn from the 64-69 brackets, followed by the 45-59 and the 40-44. The least number was drawn from the 80-84 and the 95-100 and these were represented by 2 individuals each.



In total, there were 93 male respondents and 73 female respondents. The largest numbers of male respondents were in the 40-44 and the 45-49 age brackets. The largest numbers of female respondents were in the 64-69.

Table: Classification of resource users amongst the respondents

Classification of resource users	Kipini	Ozi	Dida Waride-floodplain	Moa
Agricultural farmers	7	5	5	4
Livestock owners/Herders/pastoralists	8	5	12	7
Coastal Fishermen	9	7	0	0
Inland Fishermen	6	3	2	6
Traditional healers	4	3	1	3
Mangrove harvesters	3	5	0	0
Reed harvesters	4	8	1	3
Papyrus harvesters	2	3	2	3
Carpenters	3	4	0	4
Bee-keepers	4	3	2	5
Charcoal producers	2	2	2	7
Total number of respondents	52	48	27	42

4.2 Data Analysis

The Statistical Package for the Social Sciences (SPSS) was used to examine any cross tabulation or associations/groupings which emerge from the variables in this study, such as the physical and ecological changes, resource use patterns, deterioration in goods and services, natural resource management and transformation and loss of habitats.

To have respondents communicate their perceptions, feelings, attitudes, opinions, and evaluations in some measurable form, the study used the Likert interval scale in both numeric (by scoring them on a scale of 5 down to 1 (i.e. 5 = Excellent; 1= Poor) on each of the criteria listed and semantic forms (making extensive use of words rather than numbers). Respondents described their perceptions about the environment with semantic labels, for example (by ticking the appropriate response-excellent, very good, good, fair and poor) or 1-strongly agree, 2-agree, 3- neither, 3 disagree, 4- disagree and 5 strongly disagree).

The following scores were used to assess water quality: (95-100) - excellent: water quality is protected with a virtual absence of impairment, conditions are very close to pristine levels; (89-94)-very good: water quality is protected with a slight presence of impairment, conditions are close to pristine conditions; (80-88)- good: water quality is protected, with only a minor degree of impairment conditions rarely depart from desirable levels; (65-79)-fair: water quality is usually protected but occasionally impaired, conditions sometimes depart from desirable levels; (45-64)- marginal: water quality is frequently impaired, conditions often depart from desirable conditions;(0-44)- poor water is almost always impaired , conditions usually depart from desirable levels. The higher the score, the better the quality of water was perceived by the local community. Water scores were computed for each water source sampled/ mentioned as being of importance to the local community and their livestock. Quality was also categorized as either being suitable or not suitable for the various functions at the local level. The most common standards used to assess water quality at the local level related to livestock watering; drinking water; safety of human contact and the health of ecosystems- particularly aquatic resources-fish.

The Likert responses were collated into bar charts and analyzed using non-parametric tests, e.g. chi-square test, or Kruskal–Wallis test. The study used the Kruskal Wallis test because this is a popular approach to analyze responses using analysis of variance techniques and it was most useful for this study. The study ranked all data from all groups together; i.e., rank the data from 1 to *N* ignoring group membership. The test statistic is given by:

$$K = (N-1)\frac{\sum_{i=1}^{g} n_i(\bar{r}_{i\cdot} - \bar{r})^2}{\sum_{i=1}^{g}\sum_{j=1}^{n_i}(r_{ij} - \bar{r})^2},$$ where:

- n_i is the number of observations in group i
- r_{ij} is the rank (among all observations) of observation j from group i
- N is the total number of observations across all groups
- $\bar{r}_{i\cdot} = \frac{\sum_{j=1}^{n_i} r_{ij}}{n_i}$,
- $\bar{r} = \frac{1}{2}(N+1)$ is the average of all the r_{ij}.

The Pearson's Chi-square test was also used for analysis. The statistical symbol for Chi-square is χ and the formular for calculating is stated here- below.

$$\chi^2 = \sum \frac{(O - E)^2}{E}$$

For monitoring data collected by the artisanal fishermen, all data was managed in a Microsoft Access data base. To supplement this, the environmental indicators were compared to assess if they satisfy a predetermined selection criteria to ensure their viability. Using a score of 1-4, the study used a criteria for each potential indicator identified, with emphasis on reliability, sensitivity, representativeness, scope and applicability.

CHAPTER 5: FINDINGS (data presentation and analysis)

5.1 Status and trends of the environment from the local community perspective

The term State of the Environment normally relates to an analysis of trends in the environment of a particular place. The study has used are number of hyponyms to describe the state of environment at the selected sites. Each one of the hyponyms is an "environmental condition"). The list includes; pollution (undesirable state of the natural environment being contaminated with harmful substances as a consequence of human activities); erosion (condition in which the earth's surface is worn away by the action of water and wind); deforestation (the state of being clear of trees); depopulation (the condition of having reduced numbers of inhabitants (or no inhabitants at all); inhospitableness (the environmental condition in a region that lacks a favorable climate or terrain for life or growth).

The undergoing is an account of the perceptions of the local communities about the state of the environment. The study investigated the perceptions of the local communities essentially about how nature used to be, how nature is at present and the envisaged state of nature in the future. The study looked at the variables such as quality and quantity of water, mammals aquatic and plant/vegetation resources.

5.1.1: Water Quantity

The Tana Delta is divided by the river Tana, forming the Eastern and the Western sides of the Delta. The Eastern side of the Tana Delta is richer in terms of biodiversity concentration as compared to the Western side. This has been so by the fact that the diversion of the river at Matomba makes the Eastern side to enable the real existence of water bodies (wetlands) in that area since about 90% of the river water flows through here. During dry season, the main river from Matomba point downwards does not flow water in it. Secondly, since the Eastern side is large, there is less human settlement in the area. Communities visit the area to harvest some resources for some short time and leave e.g. fishing, building materials etc.

Although the District has several water sources such as the river Tana [main source], seasonal lakes, Moa, Shakako, Tamaso, Mlango, Shakababo, Kongolola, sea and river wetlands, many of them including earth pans and boreholes have dried up due to:-sidelining community in the management of resources by the Government; Introduction of poor Government Policies in the management of such resources and abandonment of traditional and sustainable conservation mechanisms and the introduction of modern ones.

Falling water levels in the river have resulted to 90% shift and change of the river course thereby affecting economic and livelihood activities of many people and institutions. Tana Delta is the largest deltaic ecosystem in Kenya formed by the river Tana which is the longest in the country, stretching over a total length of about 1,000 km. The river Tana has a large catchment area of about 95,000km square, which is approximately 17% of Kenya’s landmass. The river flows for most of its course across semi-arid and arid regions, while meandering through an alluvial floodplain of varying width from 2km in the middle and reaching 42km in the lower delta areas. The river enters the Indian Ocean through the main channel, the Ozi River, near Kipini town.

Seasonal flooding, deposition and erosion activities of the river cause the formation of new river channels resulting into cut-offs levees, meanders, oxbow lakes and other open water bodies. These physical river processes are the main factors that contribute to the formation and existence of an extensive floodplain with ever-changing micro-topography in the lower delta area.

The local communities have witnessed changes taking place in the course of the river and subsequently the quantity of water. More than a century ago, the flooded river cut through into a canal dug for navigation from Belazoni, on the main river, into the Ozi. This is what is considered as the original river course. During the British rule in Kenya, communication and surveillance from Coast to the interior by officials of the Colonial Government were necessitated by means of Tana River transport. The 450 Kilometer river transport between Kipini to Mbalambala in the Kora National Park was effectively covered by means of a strong well designed Pelican Boat. The river navigation was discontinued, as connecting roads were network was developed after independence and three bridges at Garissa, Ijara and Garsen to Lamu constructed. The river also reduced in volume and lagoons developed making it impossible to navigate beyond Ozi Centre from Kipini.

The local communities confirmed that as a result of flooding, the mouth of the river has shifted many times. Today, the main stream of the Tana follows an artificial course. As a result, the river now flows directly into an estuary at Kipini, rather than into the complex system of channels and distributaries leading to its old mouth at Mto Tana.

Until recently, some fresh water still flowed into the 'old' delta through one of these channels, the Kalota Brook. However, since 1988 this has been blocked by a small dam built by Pokomo farmers, who use the tidal bore to push fresh water into their fields and irrigate their crops. The Pokomo villages are mostly located very close to the water source- the river, with which their tribal life is closely bound. They refer the river as *'our brother'*- Tana is a Swahili pronunciation of the word, in Pokomo however the word is Tsano- meaning brother. Although the Pokomo are not nomadic, they have at times been forced to move as a result of the change in the course of the river.

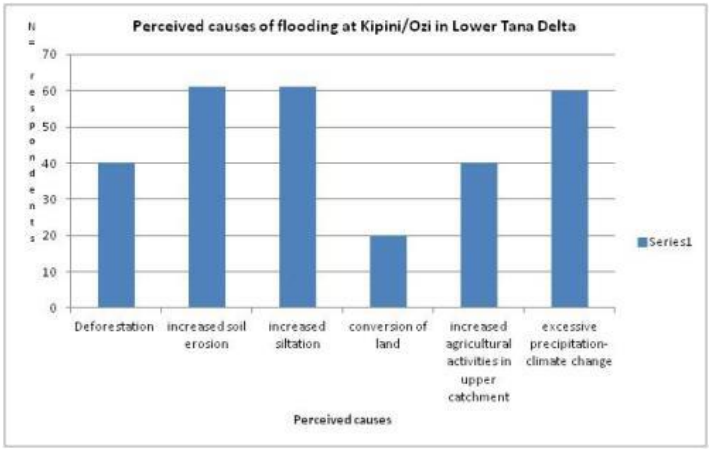
The change in the course of the river is a key characteristic of the delta and this has led to numerous efforts to manipulate a natural process as it caused untold suffering to those people that used to largely dependent on the water resources. The complexities, challenges, intrigues brought about by the change in the river course are well illustrated in the abstract attached as an Appendix, obtained from the National Assembly Official Report dated Tuesday, the 4th of April, 1995. The abstract is reflective of what the state of the river was-a lot of water was flowing towards the ocean, the river had changed its course as a result there are some areas that were adversely affected, the challenges of how to control the flow of water and options for use of the water- mainly for irrigation purposes.

Historically, the local people have been more inclined towards observing the intensity of the rain than the average rain. Floods have been a regular occurrence as result of the inflow from the upper catchment in the Aberdare Mountains and Mt Kenya. Normally, the major floods occur in April-May with a smaller, short-rains flooding in October -November. The timing,

extent and duration of the flooding vary greatly from year to year. According to the local people *'floods' are defined as evidence of water from the River Tana overflowing the banks and filling the wetlands with water'*. This is when the wetlands are described as being *'impassable as the whole area is filled with water.'* Low water levels in the river due to environmental destruction and establishment of unsustainable development projects upstream. Respondents also indicated that high sea water level encroaching rice farms in Ozi resulting to low yields production.

Perceptions of the underlying drivers of flooding reveal inconsistences among respondents. The starkest difference in perceptions appeared to be between the residents at Kipini and Ozi and those at Moa. Almost a majority of the respondents

Figure: Perceived causes of flooding in the Lower Tana Delta



Each of the communities in which interviews were conducted in this study area cited other environmental issues-excessive rainfall (according to some respondents a consequence of climate change) and ecological problems such as deforestation and erosion in the upper catchment) as causes for flooding.

Lake Munuji in Kipini village has been over-used therefore posing a threat to drying up very first especially when rains fail during this coming short rain season. Currently even the fishing activity has become very minimal since the water has become scarce and the remaining watering sites is being occupied by hippos and crocodiles who pose a big threat to human and wildlife while drawing and drinking water respectively. Fishermen have almost abandoned the fishing due to fear of being attacked by the two fierce animals. The two types of animals have become very harsh and now run after any creature that gets nearer to the water. It was noted that the lake was dominated by fish eating birds like kingfishers and pelicans seen feeding on fish.

The river channel that takes water to Moa has been blocked down completely by siltation. The water in the lake became muddy forcing the hippos to migrate to the main water channel that flows downstream to the Indian Ocean. The number of pelicans in the lake increased tremendously. This is as a result of the low water table that makes it easy to catch the small fishes in the shallow waters. The hippos in the area had also contributed towards the rapid drying of the lake. Due to their movement from the lake to the main river channel which is

nearer to one another, a drainage channel has been created and draining the water from the lake to the river channel that eventually drains the same water to the Indian Ocean. If this trend continues without a reverse, then all the lake will dry up completely creating more socio-economic problems.

At the flood plains of Dida Waride, the perception of the local community was that the area was totally dry, only black and brown sand could be noted. The area had not received rains and the river water is very low. Although the area is dry, some water birds could still be noted here and there within the open wetlands. The mostly noted bird species were cattle egrets, kingfishers, sacred ibis and glossy ibis. Since the area has become very dry without watering points, hippos and crocodiles have been forced to migrate to other areas that contain water. It was interesting to note that buffaloes had been noted openly in the wetland searching for pastures and water.

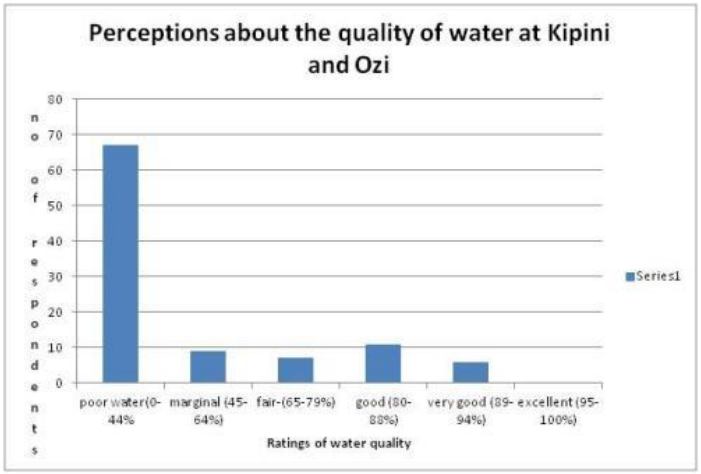
5.1.2: Water Quality

Most respondents described the quality of water in the past as being clean and free from sediments and pollution by agricultural chemicals. The colour of the water was said to be clear and the taste classified as excellent. In the past, a majority of the local residents used to draw water for domestic consumption directly from the Tana River. Over the years, there has been intrusion of saline water into the wetland due to low water level in the river. The entire floodplain in the lower parts is covered by alluvial sediments, transported and deposited during the annual flooding of the river.

Murky waters of the Tana River at the Kipini Estuary

	0 None	1-low	2-moderate	3-high	very high
Disposal of untreated sewage into water masses;	0	0	0	140	29
Discharge of industrial and domestic effluent into water masses;	0	0	2	128	39
Disposal of solid waste into water resources;	0	0	34	50	85
Oil spillage into water masses	0	0	41	85	43
Washing of motor vehicles next to lake shores, rivers banks and beaches;	0	0	65	43	61
Siltation caused by poor agricultural practices	0	0	9	13	147
Pollution from agricultural chemicals/residues	0	0	8	18	143

At least 143 out of 169 respondents indicated that pollution of the water resources from mechanized irrigation schemes occurring in the upper parts of the delta contributed was very high. They alleged that water is being polluted by agro- chemicals as well as pesticides that are extensively used in the farms. Presently, the respondents in Kipini do not use the water from Tana River for both domestic and livestock. At Kipini village they are more dependent on the boreholes for domestic use and Lake Manumit for watering of livestock. Out the 100 respondents in Kipini and Ozi, none classified the quality of water as being in excellent condition.



Response actions that have been embarked upon to improve water quantity and quality in Kipini, Ozi and Lake Moa

The respondents indicated that nothing much has been done with regards to improving the quality and quantity of water resources. The local communities through local CBOs such as TARDA have however been raising awareness at the local and national level about the impact that agricultural developments in the upper catchment is having on water quantity and quality resources. Awareness creation to Ozi community on the low river water level has also been ongoing.

Response interventions from the community perspective: Water conditions	Ratings					
	0-none	1-very low	2-low	3-average	4-high	5- very high
1.Economic incentives	169					
1.1. Transferring rights to own and manage resources to private individuals gives them a stake in conserving	97	12	33	27		
2. awareness raising		8	80	77	4	
3. Training workshops			88	56	2	
4. Governance						
4.1. Supportive laws and policies	33	89	13	34		
4.2 Provision of security of tenure	97	11	34	27		
4.3 Devolving authority to lower levels	98	10	34	27		
4.4. Institutional capacity building	37	87		45		

4.5 Responsive local and government authorities	120	30	11	8		
4.6 Traditional rules enforced by the elders	130	12	13	14		
4.7 Punitive measures (penalizing/disciplinary)	156	4	6			
5.Rehabilitation/restoration	87	9	73			
6. Campaigns			34	26	109	
7. Regular Monitoring schemes						

A majority of the respondents considered that economic incentives to improve the condition of water resources were non- existent. Serve for a limited number of individuals that are engaged-employed in water schemes, economic incentives as a measure for encouraging conservation of water resources was non – existent. Noting the high profile court cases on the Tana Delta, a majority of the residents were aware of the campaigns to save the delta. At least 109 respondents ranked the campaigns as high- as these have brought awareness to the local community about the condition of the resources in the Tana, abstraction of water sources and the land acquisition. This naturally brought on negative perceptions about supporting laws and policies as the respondents felt that they have been left to their own demise to deal with private companies that are intent on usurping land. The laws were also not existent in establishing, enforcing as well as monitoring upper limits of water abstracted from upstream. Training workshops as awareness raising were considered as key raising awareness – however a majority still felt that more needed to be done to capacitate the local communities. The respondents indicated that due to the influx of livestock herders from other areas that come to the area in search of grazing resources, there are certain conditions that need to be met to ensure that the water quality especially at Lake Manumit is at desirable level. The respondents indicated that there is need for restricting access by livestock to certain points on the river and the lake and also to repair the riparian zone by planting trees and grasses to stabilise shorelines and provide habitats. Establish upper limits for the amount of water that can be drawn from the river source in the upper catchment considered a priority.

5.1.3: Birds

The local communities indicate that they have been able to identify as many as 37 bird species within the Tana Delta. Between the years 1991-1998, at least 47 bird species were identified. Since 1998, there has been no regular monitoring. According to BirdLife International, the Tana Delta is said to be a stronghold for two near threatened Bird species, Malindi Pipit ((*Anthus melindae*) and Basra Reed warbler (*Acrocephalus griseldis*). According to the UNESCO World Heritage Centre, the wetlands, including the coastline and offshore islets, at times hold exceptional concentrations of water birds.

The local communities indicate that the Tana River Cisticola is usually found along the rice farms. They indicated that with the abandonment of the traditional rice farms, the numbers of the cisticola have reduced.

Lake Manunji remains an important water bird and aquatic animals' habitat. The species noted by the local monitors during between the month of April 2011 and October 2011 at Lake Manunji, Kipini Estuary and Dida Waride were as follows:

Observation and records of bird species between April 2011 and October 2011
Lake Manunji Lake Manunji

Species	Months in which the local community monitored the birds						
	April	May	June	July	August	September	October
Sacred ibis	10	25	0	0	13	18	35
Eurasian Spoon bill	7	11	0	0	2	27	31
Goliath heron	1	0	0	0	3	6	13
Great egret	21	0	0	0	13	15	19
Glossy ibis	40	0	0	0	4	19	35
Black headed gull	3	0	0	0	2	1	0
White stock	6	0	0	0	2	6	1
Black headed heron	1	0	0	0	3	2	4
Grey heron	1	0	0	0	0	1	3
Malindi Pipit	0	0	0	0	0	0	0
Basra reed warbler	0	0	0	0	0	0	0
Tana River Cisticola	0	0	0	0	0	0	0
White necked stork-	43	0	0	0	0	0	0
White-backed night heron	0	36	0	0	0	3	26
Black heron	0	53	0	0	2	7	29
African spoon bill	0	10	0	0	24	36	0
Yellow billed storks	0	0	347	780	800+	163	30
Saddle bill storks	0	0	1	4	4	6	0
Hadada ibis	0	0	24	57	42	5	0
Hammerkops	0	0	12	8	13		9
Demorphic egrets	0	0	26	52	24	0	0
Great white pelicans	0	0	103	240	300+	400+	0
African darters	0	0	56	133	139	146	0
Egyptian geese	0	0	0	4	12	17	0
Spur-winged plover	0	0	0	6	34	67	8

NB: During times when the water was low in the lake, many birds were counted due to the fact that they were attracted by the feeding of fish and other micro-organisms unlike when the lake was full, no bigger dry place around the lake and could not easily get feeding stuff.

During the month of July, the number of water birds increased at Lake Manunji as compared to the previous month. Birds have been attracted by the concentration of fish, for example the fish eating birds like yellow- billed storks, African darter and great white pelican. Again, during this time of dry weather, the lake becomes the center of conflicts eruption since it is the only source of water for farmers, pastoralists and wildlife. Incidences of livestock and wildlife crop destruction around the lake are very common. Already at the moment, there are high tensions between farmers and pastoralists as livestock have to pass through farms to get access to water.

Kipini Estuary

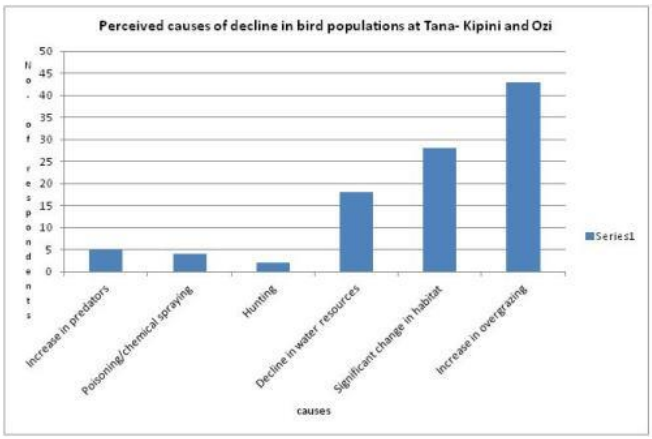
Species	Months in which the local community monitored the birds						
	April	May	June	July	August	September	October
Saddle bill stock	1	0	0	0	0	0	0
Lesser black-backed gull	3	0	0	0	2	0	0
African fish eagle	2	0	0	0	2	1	0
Montagus harrier	1	0	0	0	1	0	2
Shy albatross	4	0	0	0	0	2	3
Western reef heron	2	0	0	0	0	0	1
Sooty tern	7	0	0	0	5	3	2
White stock	6	0	0	17	13	1	3
Heuguns gull	15	0	0	0	0	0	1
Sooty gull	20	0	0	24	21	18	31
Lesser gressed tern	1	0	0	0	2	5	4
Malindi Pipit	0	0	0	0	0	0	0
Basra reed warbler	0	0	0	0	0	0	0
Tana River Cisticola	0	0	0	0	0	0	0
Yellow billed stork	0	0	7	0	2	6	13
Little egret	0	0	1	0	0	3	2
African fish eagle	0	0	1	1	2	6	9
Dimorphic egret	0	0	0	2	0	0	0
Ring-necked dove	0	0	0	15	0	5	2
Red-eyed dove	0	0	0	6	3	0	0
Emerald-spotted wood dove	0	0	0	9	12	4	8
Great white egret	0	0	0	4	2	3	0
Goliath heron	0	0	0	4	1	0	3
White-backed night heron	0	0	0	2	1	0	0

NB: Birds were noted during low tides when there is dry land along the beach. The year experienced rough conditions of the sea hence, had short times of low tides but otherwise most of the time, the sea experienced rough waves with a lot of noise that scared the birds.

Breeding nests for weaver birds at Mugombani wetland in Ozi Village

It was reported that in March 2011, TARDA used aeroplanes to eradicate weaver birds. According to the community the numbers are not known, but they indicate there were many birds that were killed. At least 4 respondents from Kipini and Ozi alluded to poisoning/chemical spraying as being a cause for the decline in bird species.

Signficant change in habitat/loss of breeding areas was cited as a cause by at least 28 of the 100 respondents, specifically in the Kipini and Ozi areas. A majority of respondents in Kipini and Ozi, comprsing of 43 out of 100 respondents, cited overgrazing as a major cause of decline in bird populations.staging, resting, nesting and feeding ground for resident and migratory water birds



Didewaride

Species	Months in which the local community monitored the birds						
	April	May	June	July	August	September	October
Great white egrets	0	0	36	50	42	0	70
Kingfishers	0	0	23	40	6	0	56
Long beak peakers	0	0	0	20	4	1	0
Malindi Pipit	0	0	0	0	0	0	0
Basra reed warbler	0	0	0	0	0	0	0
Tana River cisticola	0	0	0	0	0	0	0
Cattle egrets				3000+			4000+
Carmine bee-eaters	0	0	500+	2000+	1000+	2000+	2600+
Crowned Cranes	0	0	0	2	0	5	7
Yellow billed stork	2	9	39	0	0	3	48
Sacred ibis	39	48	73	52	67	47	70

NB: Cattle egrets and Carmine Bee eaters are many as they are both found during dry and wet season following livestock to catch flying insects.

During the month of June, the bird species also continued to decline by moving further to watering points. The bird species noted were great white egrets, kingfishers, long beak peakers and others not identified.

During the month of July, the drying up of the wetlands continued but remains wet around the river channel from Matomba brook in Garsen that takes water to the Indian Ocean via Shakako, Moa, Chalaluma, Reketa, Kau, Mbililo and to Ozi. The monitoring therefore included where there is water in the river channel and water ponds.

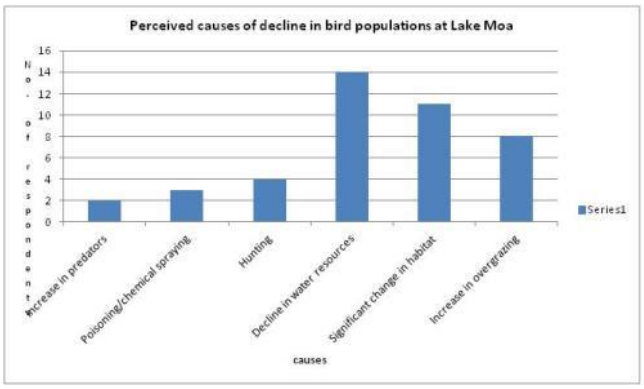
Lake Moa

Species	Months in which the local community monitored the birds						
	April	May	June	July	August	September	October
Cattle egrets	30	49	164	254	59	23	2300+
Egyptian Geese	-	2	5	17	-	-	29
Sand pipers	-	34	56	27	4	-	143+
Sacred ibis	76	G3	42	69	81	53	123
Spur-winged plover	35	46	72	49	31	27	175
Glossy ibis	69	61	52	63	71	78	96
Pied kingfisher	8	18	47	36	12	20	40
Little stilts	2	5	64	68	42	23	116
African darters	-	3	14	8	-	5	15
African jacanas	-	2	13	7	-	4	15

During the month of April, the local monitors observed that the water volume in the lake was very low. However there were a substantial number of water birds, ranging from Common sand pipers, Hornbills, African pied wagtail, Egyptian geese, Cattle egrets in hundreds, African darter as well as weaver birds preparing their roosts, ready for breeding

During the month of June, water birds populations were also seen to be declining due to less feeds around Lake Moa. However, twenty bird species were counted but only cattle egrets, common sand piper, little stilt, Egyptian geese were identified and a huge congregation of doves was experienced around the village and forest areas. This is due to the ripening and splitting of Spirostachys venenifera seeds that is edible by the dove family. There was a tremendous decline in the fish catch towards the end of the month due to the cold weather that makes the fish to go to hiding in deep waters or under vegetation where there is at least some warmth.

During the month of July, many caterpillars were noted in the grazing areas with a high number of the hatched grasshoppers. This has therefore attracted many birds in the area like the cattle egrets and carmine bee- eaters who were feeding on these insects.



Of the 42 respondents at Lake Moa, at least 14 indicated that a change in the water resource was the main cause of the decline in bird populations. Considering that siltation has been cited as the major cause for the change in water course-thus affecting the quantity of water in the lake, the response from a majority of interviewed residents from Moa was not a he surprise.

Response actions that have been embarked upon to reduce decline of birds and habitats

Response interventions from the community perspective: Bird and Habitats	Ratings					
	0-none	1-very low	2-low	3-average	4-high	5- very high
1.Economic incentives	169					
1.1. Transferring rights to own and manage resources to private individuals gives them a stake in conserving	97	12	33	27		
2. awareness raising		8	80	77	4	
3. Training workshops			88	56	2	
4. Governance						
4.1. Supportive laws and policies	33	89	13	34		
4.2 Provision of security of tenure	97	11	34	27		
4.3 Devolving authority to lower levels	98	10	34	27		
4.4. Institutional capacity building	37	87		45		
4.5 Responsive local and government authorities	120	30	11	8		
4.6 Traditional rules enforced by the elders	130	12	13	14		
4.7 Punitive measures (penalizing /disciplinary)	156	4	6			
5.Rehabilitation/restoration	87	9	73			
6. Campaigns			34	26	109	
7. Regular Monitoring schemes						

5.1.4: Land cover patterns

The respondents indicated that at least eight major land use/cover patterns exist within the Lower Tana Delta and these are forests, mangroves, flood plain grass land cover, woody vegetation cover, palm trees, cultivated land, settlement and bare land were identified by the local community. According to the respondents, all the major land use cover patterns with the exception of bare lands have decreased significantly over the last 40 years. Cultivated land, bare

land, and settlement increased small to large in Kipini, Ozi and Dida Waride. The grass land cover decreased from extremely large to very small in all the three villages. This suggests that the expansion of other land use/cover types were at an expense of grassland cover; the main feed particularly for cattle, resulting in negative effects on local ecology and community. This has forced the local communities to expand cultivation onto marginal semi-arid lands that possibly resulted in the ecological disturbance of grazing land environments.

Descriptions of land use/land cover patterns between 1940 and 2010 of the study areas at Kipini, Ozi and Dida Waride and Lake Moa	
Land use/land cover patterns	Descriptions
Grass covered	Areas with permanent grass cover used for grazing including communal and protected areas for calves. This indicates grazing areas outside tree canopy
Natural forest	A forest which has spontaneously generated itself on the location; forests not subject to regeneration by sowing or planting
Mangrove plantations	Mangroves that grow in dense thickets or forests along tidal estuaries, in salt marshes, and on muddy coasts. The term also applies to the thickets and forests of such plants.
Woody vegetation cover	Areas with trees mixed with bushes and shrubs, with little use especially for cattle. All the areas covered with trees forming closed canopy or nearly closed canopies (encroached area), which is not accessible for livestock to grazing under it.
Cultivated land	This unit includes areas used for rain-fed cultivation practiced by agro-pastoralism systems in the study areas.
Bare land	Areas with no vegetation, which occur in rangelands including gullies and exposed rocks, which have no vegetation cover.
Settlement	Rural settlements that is associated with pastoral production systems. Some woody covers that are communally found around homesteads were included in this category.

(a) Forests

It said that in the past there were numerous dense forests within the Kipini area. These communities identified (1) that there are three types of woodlands integral to their livelihoods, and (2) express the desire for the forests to be conserved, rehabilitated, and expanded. The three forest types are: Riverine forests adjacent to the river course; Floodplain forests ('madzini') a short distance from the river course and of greatest importance to the local communities;Thicket woodlands ('gubani') on dryer areas away from the flood plain. Over the years as the settlements and population has increased, these patches of forests have been rapidly disappearing.

Presently, small fragments of riverine forest, not nearly as extensive as the forests north of Garsen, occur along the present or former river courses. *Diospyros* and *Sorindeia madagascariensis* dominate the main canopy, with *Cola clavata* and *Garcinia livingstonei* beneath (Ecosystems Ltd. 1985). *Phoenix reclinata* and *Barringtonia racemosa* are also prominent (Survey of Kenya 1984).Other tree species on the Eastern side of the wetland were noted as follows: - *Phoenix reclinata, Spirostachys venenifera, Polysphaeria multiflora, Rivolfia*

mombasiana, Cordia faulkheria, Terminalia brevipse, Tamarindus indica, Indigofera schemperi, Launea stuhlmanni, Kigelia africana, Salvadora persica and Barringtonia racemosa. Harvesting of vegetation materials by neighboring locations.

One of the few remaining forest patches at Kipini

In the past, the traditional leaders in Kipini set a day in month- appointed times at which people could be allowed to extract resources from the forests. i.e. building materials. This is a practice that is no longer in force and the result of this is the rapid rate at which patches of forests have been cleared. Local communities are practicing slash-and-burn agriculture to a very large extent within the Kipini area and there was evidence of this in many agricultural fields within Kipini. Clearing of land for agricultural purposes, logging and charcoal production are on the rise at Kipini. The respondents indicated that the apart from over harvesting, conversion of forests to agriculture, destruction of vegetation by the El-Nino of 1997/1998 and lack of knowledge on forest policy and guidelines have significantly contributed to the decline in forest resources. They also allege communication breakdown and linkage between the Ozi community and the Government representatives on forest management.

Information obtained from focus group discussion with the locals indicated that the forests are an important source of honey. The forests have traditionally been used *as burial grounds:* Unlike most Bantu tribes who bury their dead within the homesteads, the Pokomo buried their kith and kin in the forests. Thus the forests had a central place in the culture of the people. The forest, though near the village was dense and intact although the residents depended on it for building materials. This was done sustainably as the locals have the knowledge of sustainable harvesting of forest resources.

Response actions that have been embarked upon to reduce degradation of forests
The sacred forests of the Mijikenda people are called kaya (plural Makaya). Many of them were originally fortified villages surrounded by thick belts of lowland tropical forest. Access to the village was limited to one or two paths through the forest, and use of the forest vegetation was limited to gathering of medicinal herbs. Cutting of trees for timber, grazing of livestock, and clearing for farmland were strictly prohibited. These rules were enforced by the kaya elders who were also responsible for the care of the sacred objects (fingo) which were buried in the kaya and were believed to be essential to the well-being of the community. The kaya forests were

also places for prayer, not only for the elders on behalf of the community but also by individuals seeking help in problems facing their daily lives.

From the middle of the last century the reduced threat from other ethnic groups and the increase in the Mijikenda population caused people to move out from the original kaya settlements to establish new villages, but for many decades, the elders continued to live, and be buried, in the kaya forests. The Mijikenda maintained respect for the sanctity of these sites despite their increasing Islamicization, and the kaya forests survived as islands of indigenous vegetation while forests were cleared elsewhere along the coastal strip. In 1993 it was estimated that about 2000 hectares of kaya and sacred groves survived in Kwale and Kilifi Districts. More than half the known rare trees and shrubs of Kenya exist in Coast Province, many of them in the small patches of rapidly degrading kaya forest, and it is likely that a number of extinctions have already occurred.

Respondents indicated that re-afforestation of destroyed vegetation in Mugombani wetlands after the El-Nino has been ongoing, albeit at a slow rate. The Ozi SSG has forcefully warned neighboring locations to stop vegetation harvesting from its location. In a noted incident, all Ozi conservation CBOs seized and took away the already made timber by Chara community. Recruitment of community forest scouts to assist in the monitoring of the forest.

Response interventions from the community perspective: forestry	Ratings					
	0-none	1-very low	2-low	3-average	4-high	5- very high
1.Economic incentives	169					
1.1. Transferring rights to own and manage resources to private individuals gives them a stake in conserving	169					
2. awareness raising		53	35	77	4	
3. Training workshops	23		88	56	2	
4. Governance						
4.1. Supportive laws and policies	33	89	13	34		
4.2 Provision of security of tenure	97	11	34	27		
4.3 Devolving authority to lower levels	98	10	34	27		
4.4. Institutional capacity building	37	87		45		
4.5 Responsive local and government authorities	120	30	8	11		
4.6 Traditional rules enforced by the elders	111			58		
4.7 Punitive measures (penalizing/disciplinary)	10	34	2	123		
5.Rehabilitation/restoration		46	25	98		
6. Campaigns			114	54		
7. Regular Monitoring schemes	14	18	114	23		

(b) Mangroves:

The local community was able to identify as many as nine species of mangroves; all found around the estuary in Kipini and Ozi locations. Of the nine, four are common to the region while the rest are just known to be present. Below is a table showing the list/status of the mangroves at Ozi and Kipini according to the respondents.

Table: List/status of the mangroves at Ozi and Kipini according to the respondents

Scientific Names	Local Names	Abundant	Common	Present	Rare	Very Rare	Absent
Heriteria litolaris	Msukandazi		✓				
Avicinia marina	Mto		✓				
Rhizophora micronata	Mkoko						
Bruguiera gymuorhiza	Mshizi/Muia			✓			
Ceriops tagal	Mkandaa			✓			
Lumitzera racemosa	Mkanda dume			✓			
Someratia alba	Mpira/Mlilana			✓			
Xylocarpus granatam	Mkomafi		✓				
Xylocarpus molucensis	Mkaa Pwani			✓			

A mangrove tree on the shores of River Tana- eastern side of River Tana at Kipini

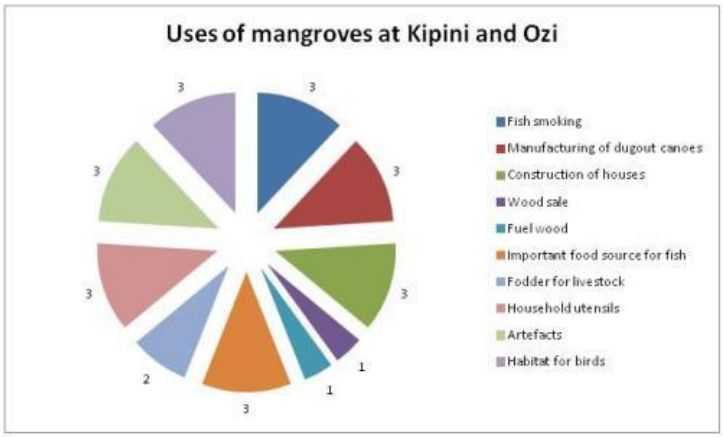
The mangrove vegetation on the Northern edge of Mugombani wetland was noted to have been affected by the dry weather conditions, thus changing the leaves to yellow and shading their leaves. About 40% of the mangroves have died and fallen down on the ground. Several foot prints of buffaloes and elephants were noted in the mangrove wetland of Mugombani. There are several dead logs of mangroves in the area. There were many seedlings of mangroves noted around the watering points. There was no other tree species in the wetland apart from mangroves. Poaching of mangroves by outsiders from Kipini, Kilelengwani, Lamu, Ziwayu, Ngomeni, Watamu and Shimoni.

The mangroves provide vitally important spawning and nursery grounds for many species of fish and crustaceans. The mangroves are more concentrated on the western side of River Tana at Ozi. There has however been intensive harvesting of mangroves and the density has declined over the years. The mangroves are hardwood and are widely utilized for constructing boats such as the one shown in the picture below.

Interior of the Ozi Beach Management Unit boat as it was being constructed in April 2011

These are also used for roofing and in construction of houses. Mangrove timber is dense and has characteristic unusual shapes. The local people also split open and gathered large aquatic worms, or wood oysters as some people call them, for food from the dead logs and branches of this plant. The young leaf shoots and seeds of this plant are roasted and eaten as food. Medicine is made from uncooked leaves and sap. The branches with bends in them were made into boomerangs. Weapons and tools were usually made from the thicker main trunk and branches of this tree (careful preparation needed). This plant indicated a well-sheltered area for hunting fish and crabs. This plant also indicated fresh drinking water can be found nearby. (Mason 2001). The white mangrove was used to make shields. It is also strongly believed that fish smoked with mangrove woods are tastier. Due to a thriving fishing industry as a source of livelihoods, this is has partly contributed to the massive decline of the mangrove trees.

The figure below shows the uses of mangroves as perceived by the local community at Kipini and Ozi.



The scores denotes: 3- very important; 2-important and 1-less important. Fish smoking, manufacturing of dugout canoes, house building, and wood selling represent 48% and are all the activities related to the exploitation of mangrove wood, confirming its importance in the area under study. Mangrove use for wood sale and fuel wood is considered less important and located around the Bekumu fishing grounds of which the main activity is catching the small shrimp (Nematopaleamon hastatus) (popularly called Njanga in Cameroon) which is sold dried-smoked.

Response actions undertaken in the past to improve the condition of mangroves include:
Arrest mangrove poachers and take them to the police for further action. However, it has been noted that no action is taken against them and this has created enmity between the arrested and the SSG. Use other NGOs strong CBOs for further assistance e.g. Nature Kenya and TADECO.

Reclaiming part of the shoreline at Kipini at the point where Tana River enters the ocean- by planting mangroves which are essential habitat for fish

A section of the beach has high silt deposition and a community group in Kipini Township is undertaking mangrove planting along the beach.

Response interventions from the community perspective: mangroves	Ratings					
	0-none	1-very low	2-low	3-average	4-high	5- very high
1.Economic incentives	169					
1.1. Transferring rights to own and manage resources to private individuals gives them a stake in conserving	169					
2. Awareness raising		53	35	77	4	
3. Training workshops	23		88	56	2	
4. Governance						
4.1. Supportive laws and policies	33	89	13	34		
4.2 Provision of security of tenure	87	15	34	27	6	
4.3 Devolving authority to lower levels	98	10	34	27		
4.4. Institutional capacity building	37	87		45		
4.5 Responsive local and government authorities	120	30	8	11		
4.6 Traditional rules enforced by the	111			58		

elders						
4.7 Punitive measures (penalizing/disciplinary)	10	34	2	123		
5.Rehabilitation/restoration		46	25		98	
6. Campaigns			113	56		
7. Regular Monitoring schemes	14	18	114	23		

(c)Flood Plain Grasslands

Some 67,000 ha of the delta are covered by floodplain grasslands, subject to seasonal flooding (Njuguna 1992). The extensive areas with heavy clay soils are covered by grasslands dominated by *Echinocloa haploclada*, along with *E. staginina*, *Sporobolus helvolus*, *Panicum maximum* and *Cynodon dactylon*. In areas that remain seasonally flooded for long periods, the sedge *Cyperus rotundus* dominates, with *Ecinochloa colonum*. Grasslands of *Digitaria alscendens* and *Sporobolus confunis* occur in more elevated, sandy areas, such as the levees along old river courses.

The image below show the dry conditions of the grassland 'wetland' areas during the dry period. The respondents defined a wetland as (area/areas that are saturated for a long, allowing growth of grasses used as pasture for livestock /where livestock graze as a result of pastures that are abundant due to floods). Often, the spatial extent of wetlands can be hard to define, especially where there are gradual changes from dry to wet conditions and seasonal variability.

Pastures for livestock grazing had become limited. However, it was reported that livestock from as far as Ijara, Wajir, Mandera, Eastern Province and Northern Tana had converted into the delta as an alternative grazing area. The concentration of such external pastoralists into this area gives an alarm for the emerging of ethnic conflicts/clashes amongst the internal and external pastoralists. However, the local and the incoming pastoralists had made an agreed memorandum for grazing in the area and whoever could break it, the concerned shall leave the area of the delta to somewhere else outside the area. This memorandum had and until today contained a peaceful environment in the grazing areas of the delta since everybody is afraid of losing his livestock after leaving this area during this time when it remains the only alternative suitable grazing land. The contents of the memorandum were:-

- Herd boys should be accompanied by at least older ones or an elder who could be monitoring the moves of the young herd boys.
- External livestock should not be grazed near established villages but should maintain their animals far away from such places.
- Any emerging problem should be attended by the concerned parties immediately it occurs or when rumors are circulating for a problem to occur.
- Local elders should be updated of the pasture conditions every week by those grazing in the interior of the delta.
- Any incoming livestock should report their presence to the nearest local chief and state clearly their destination point.

Due to the lack of rains and flooding during the last season, milk production had declined tremendously since pasture regeneration and growth was very poor. Moderate pastures are found within water points and such places are dominated by crocodiles that attack the livestock while grazing in such watering points. The agricultural farms did not produce any yield as they withered even before seed production stages and the stalks had therefore to be fed to the livestock. Buffaloes and hippos are also very many in the grazing areas and therefore compete with the livestock. However, no cases of wildlife attack to human beings had been reported apart from crocodiles that are really a menace to the livestock. The herd boys use canoes when crossing from one river channel to the other while in the grazing areas.

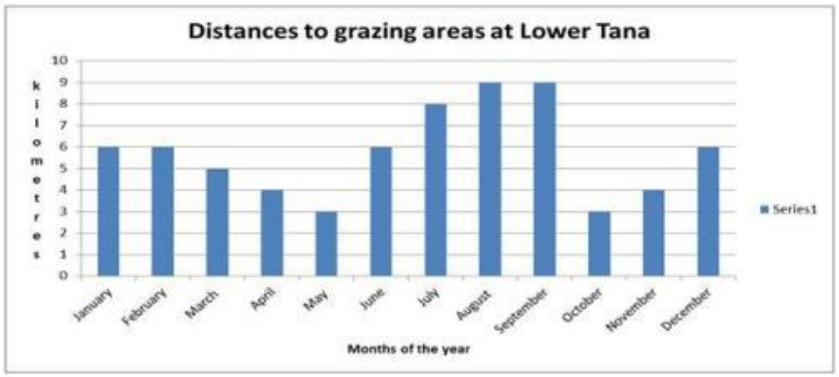
The herd boys sell the milk to the villagers in order to buy food stuff for themselves while looking after the livestock in those areas. Since livestock from outside are many and have to get food from the sale of milk, there had been high competition in the smell of the milk. This therefore resulted to the lowering of the milk price. Although the locals had to complain since theirs was losing market, they resolved to become middle business people. The locals buy the commodity from the herd boys and sell to the public at high prices including their own milk that earlier was not making profit. There established a booming milk trade in the delta, realizing good profit from it. This acted as an alternative lifestyle to overcome climate change.

Use of the land for livestock activities

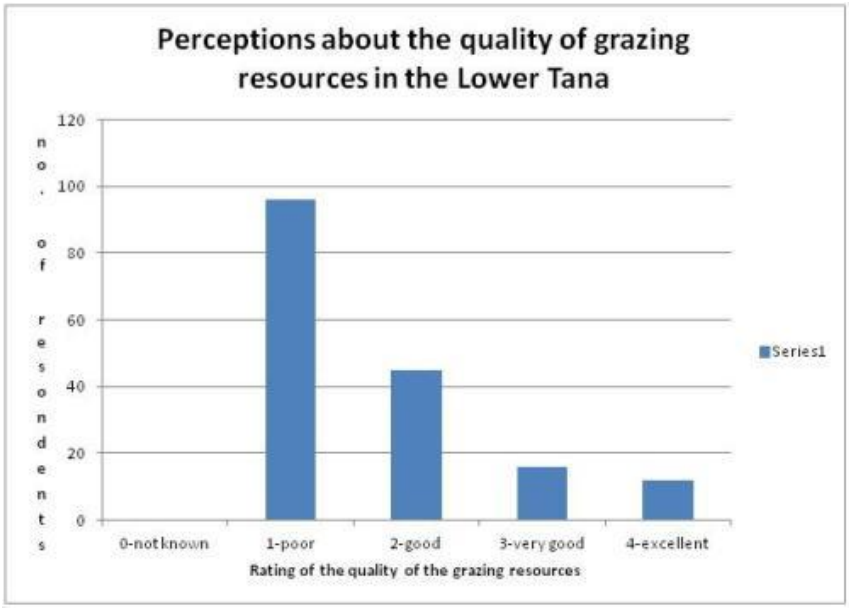
Table: Activity calendar for livestock – keepers at Ozi, Kipini and Dida Waride Villages of Lower Tana Delta

Month	Activity
January	Lean period for the pastoralists; Livestock move towards dry season grazing areas ;Decline in livestock prices and water stress in the traditional grazing areas
February	
March	
April	Livestock move towards the traditional wet season grazing areas; High Calving and lambing rates.
May	
June	
July	Livestock move towards the fall back dry seasons grazing areas (riverine and delta); Water and pasture stress experienced in the hinterland pastoral dominated areas; High incidence of conflicts between farming and pastoral communities.
August	
September	
October	Livestock move back to the traditional wet season grazing areas; Increased milk yield; Livestock move back to the traditional wet season grazing areas; Calving rates increases; Decline in livestock prices
November	
December	

The figure below further illustrates that between July and September, livestock have to travelled for relatively longer distances in search of grazing- an average of 8km one way, compared to the month of May, when an average of 3kms in covered in search of grazing. The month of May is when the livestock frequently use the traditional wet season grazing areas.



Until very recently, the rangelands were considered by a majority of the respondents to be one of the best grazing lands in the Lower Tana Delta. This was probably related to the low status of degradation patterns, strategic management of available resources by the pastoralists such as avoiding overstocking, unrestricted seasonal movements between dry and wet seasons and separate grazing culture for animals through categorizing by age and sex, lactation period and health conditions. In the last few decades, increased grazing pressure and development interventions (e.g. road construction, water developments etc) by government and non-government organizations resulted in degradation of the rangelands as a result of which a change in land use/cover pattern prevailed in the area. Obviously, this could be partly associated with a change and weakening of the traditional strategic management of the rangelands.



During the month of April 2011, the wetland at Dida Waride was very dry and without grazing pastures. The pastoralists moved the livestock to Assa and Galana Ranch areas in the hinterland

as the area had received some rains earlier. The remaining livestock in the villages starved resulting to many cases of livestock deaths, as carcasses could be seen.

A livestock carcass on the outskirts of Dida Waride village. The livestock succumbed to water shortage and lack of grazing resources

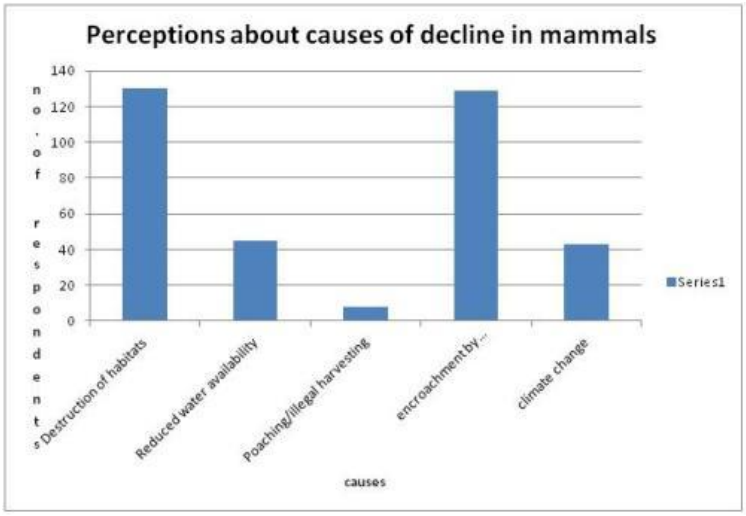
Response actions to prevent further degradation of grass resources

Response interventions from the community perspective: Grasslands	Ratings					
	0-none	1-very low	2-low	3-average	4-high	5- very high
1.Economic incentives	169					
1.1. Transferring rights to own and manage resources to private individuals gives them a stake in conserving	97	12	33	27		
2. Awareness raising		8	80	77	4	
3. Training workshops			88	56	2	
4. Governance						
4.1. Supportive laws and policies	33	89	13	34		
4.2 Provision of security of tenure	97	11	34	27		
4.3 Devolving authority to lower levels	98	10	34	27		
4.4. Institutional capacity building	37	87		45		
4.5 Responsive local and government authorities	120	30	11	8		
4.6 Traditional rules enforced by the elders	130	12	13	14		
4.7 Punitive measures (penalizing/disciplinary)	156	4	6			
5.Rehabilitation/restoration	87	9	73			
6. Campaigns			34	26	109	
7. Regular Monitoring schemes						

5.1.5: Mammals

Although their numbers have declined considerably, the area is home to elephants, crocodiles, elephants, African buffalos, hippos, baboons, reticulated giraffes, vervets, black and white colobus and sykes monkeys, Burchell's zebras, waterbucks, bush bucks, lesser kudus, gerenuks, desert warthogs and elands. Endangered species of animals such as Ader's Duiker, the Cheetah, African Wild Dog or "painted wolf" as well as the rare coastal topi are found in Kipini.

Although the Pokomos are cultivators of the soil, they are also traditionally hunters and fishermen as well. Their hunting customs, taboos and traditions show that the practice was much revered amongst the community. No hunt used to take place without the authorization of the 'wajiko' who chose a day considered to bring good tidings- a lucky day, performed incantations to ensure success and insisted on the observance of the complicated etiquette regarding the distribution of meat. Amongst the favourite animals hunted by the Pokomo were the crocodile- they however always ensured that the eggs of the crocodiles were not destroyed. They also used to hunt hippos as well as elephants before the introduction of the game laws. Each of these animals also had specific ceremonies conducted for them and they always celebrated being the custodians of the wild animals through song. In the present day, illegal hunting of wildlife is said to be occurring. The illustration below shows the perceived causes of decline in mammals in the Lower Tana area. Destruction of habitats and encroachment by settlements and agriculture due to the ever increasing population in the Lower Tana delta were both identified by most of the respondents as being a major cause for the decline in mammals.



5.1.6: Aquatic life; Fish/Turtles/Whales/Dolphins

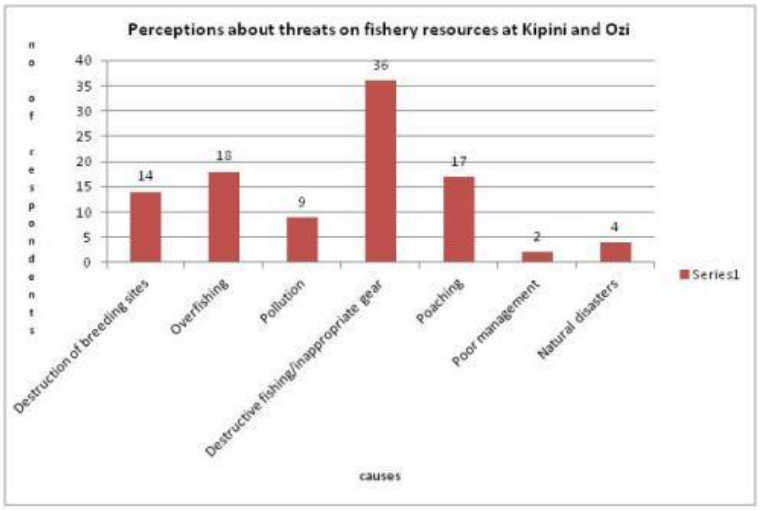
(a) Fish

Over 50% of the sampled respondents practice fishing as the primary source of livelihood, while at least 30% are engaged in farming activities. At least a total of resource users were asked about their perception about the condition of aquatic resources. The respondents rated a five point Likert scale assessing their perception- with a scale on which 0 denotes lack of knowledge about how the condition is and with 5 denoting that the condition of biodiversity is excellent. Fishermen in Kipini and Ozi village confirm that about a decade ago, fish stocks in the River Tana and the Indian Ocean were so plentiful that they would throw the excess catch on to the banks. These days the fisheries have been over-exploited and it is becoming harder and harder

to land a full catch. At Lake Moa, the fishing activity that used to be very famous had then declined tremendously and if the situation remains as at now, fish may become extinct from the area. Fish species that were recorded as being common at Lake Moa are .....

The Tana River area is known for freshwater catfish (Clarias gariepinus) landings. The fishermen indicated that the following species are commonly caught- 'tazanda', 'mkizi', 'kinungwe', 'tamamba' and 'bengusi'. The marine catfish is treated as a low value fish by prawn trawlers in Kipini. Fishing methods include the use of fish hooks, long lines, fishing nets, set monofilament nets, basket traps as well as dividing.

The respondents attributed overfishing, illegal fishing, by- catch as major causes for the decline of the fish resources over the years. At Kipini and Ozi, the fish catch still continues to decline and species like mud fish, cat fish and the labeos have become rare species attributed by low breeding rates due to reduced floods. Floods determine the level of fish breeding because during this time, conducive environments are created including sites. Prolonged droughts therefore limit the fish breeding rates. At Lake Moa, the major challenge to the fishing industry is the pollution of the water sources.



Both local and immigrant fishermen contribute to the challenges faced in the fishing industry especially in coastal fishing. Migration is said to occur both within Kenya and from neighboring countries into Kenya. Almost 90% of the recognized area fishermen migrated out of the vicinity in search of green pastures in terms of fishing. Some had moved as far as Milihoi in Lamu district as alternative fishing grounds. The destinations most frequently cited by Kenyan migrating fishers were sites within the districts of Lamu, Tana Delta, Malindi and Kilifi, including Kipini, Ozi, Mayungu, Ngomeni, Takungu and Watamu. Tanzanian fishers are known to frequently enter Kenyan waters to fish. The destinations most frequently cited by Tanzanian migrants were the districts of Msambweni (Gazi, Shimoni, Vanga, Jimbo), Tana delta (Kipini, Ozi and Ziwayuu), Malindi (Malindi, Watamu, Mayungu, Ngomeni) and Kilifi (Takaungu, Mnarani). However, surveys and interviews indicate that foreign migrant fishers along the Kenyan coast come from a wide range of origins, including the islands of Pemba and Tumbatu, as well as mainland Tanzania. Kenyan fishers also migrate to other areas within the country, and a pattern can be discerned where Kipini and Lamu are target areas for fishers migrating from Watamu, Ngomeni and Kilifi. Kipini fishers also go to Lamu. Fishing effort, catches, and target species.

On average, migrant fishers spend 7.7 hours/day fishing compared to locals who spend an average of 6.0 hours/day. This result in an overall fishing effort which is higher for migrant (188 hours/month) compared to local fishers (150 hours/month). Although somewhat higher for migrant fishers, reported catch on a poor, as well as a normal day, differs only marginally. However, reported catches on a good day are strikingly higher for migrants (514 kg compared to 154 kg) and indicates that on average migrant fishing units have the potential to catch significantly more than local crews. Migrant fishers surveyed in Kenya targeted primarily shark (papa), Kingfish (Nguru, a Scombrid) and other semi-pelagics such as Kolekole (Carangids), Jodari (Carangids), red snappers, and a variety of Lethrinids (Changu) and rabbitfish (Tafi). In terms of species actually caught, it is interesting to note that most species are cited as caught by both locals and migrants but sharks, semi-pelagics (e.g. Nguru, Sehewa, Jodari, and Kolekole), Lethrinids and red snappers are all more frequently cited as caught by migrant fishers.

The catch of fish in the ocean varies according to season. During the long rain season, there is high fish catch as compared to the short rain season. During high water volume, the ocean becomes very dangerous to the fishermen since it creates very strong waves especially when the tide is receding.

(b) Turtles/whales and dolphins

Turtles nest at Kipini each year. All five species of marine turtles occurring in Kenya's waters appear in the World Conservation Union red list and are listed either as endangered or critically endangered, and the Kipini coastal area has been identified as a key nesting area and foraging ground for the rare and threatened sea turtles in Kenya. There are numerous threats facing turtles and this range from; loss of nesting habitat- turtles are known to have an affinity for their nesting beaches, therefore a loss of even a single beach can have serious effects, increased human pressure, poaching, artificial lighting, beach erosion, predators, commercial fishing- hunting for food and shells. Even though hunting of turtles is banned, incidental taking of turtles during other fishing operations remains a major threat.

When a fishing net or hook is tossed into the ocean – the catch that is hauled back out often contains much more than the fishermen intended. Collectively, all marine life unintentionally caught while fishing for other species is called by catch. Sadly, many ocean creatures like sea turtles and dolphins are helpless victims of by catch along with corals, sponges, and a variety of other marine plants and animals. Each year millions of ocean creatures are killed or injured as a result of by catch. Recent estimates show that for every four pounds of fish caught worldwide, fishermen throw away more than a pound (by catch) of other marine animals. In shrimp trawls the ratio is fatally worse: for every pound of shrimp, four or more pounds of unwanted creatures die. What happens to these unwanted animals once they are caught? They are usually tossed overboard either already dead or severely injured. Even fish of the target species that are an undesired sex, size or quality are often thrown overboard as by catch.

Cetaceans (whales, dolphins and porpoises) also die as by catch each year, because they are unable to escape when caught in nets. Birds dive for the baited hooks on long fishing lines, swallow the bait (hook included) and are pulled underwater and drowned. By catch is a serious environmental problem because valuable living creatures are wasted, food webs are disrupted,

populations of endangered species are put at further risk, stocks that are already heavily exploited are further impacted and ecosystem alterations impact our ocean health worldwide.

High levels of by catch usually results from the use of fishing gears that are not selective. This means that instead of adapting the fishing gear to catch a specific type of fish - the fishermen cast the widest net possible and cull through what they have caught - intended or unintended. Different types of fishing practices result in different species being killed as by catch: nets kill dolphins, porpoises and whales, longline fishing: kills birds, sea turtles sharks and fish. While bottom trawling can devastate entire marine ecosystems destroying the living structures on the sea floor (sponges, corals) that provide hiding, feeding and breeding areas for many important fish species. A single pass of a trawl removes up to 20 percent of the seafloor fauna and flora.

Loglines are fishing lines up to 40 miles long. Each longline can have from a few hundred to thousands of deadly hooks. They kill numerous fish and shark species as well as hundreds of thousands of endangered and threatened turtles, marine mammals, and sea birds each year. The fishing gear commonly used at Kipini is the line largely due to the fact that the fishing grounds at Kipini are more open pelagic. Traps are also normally used by locals in shallow waters such as sea grass beds or on reefs.

Response actions to prevent further degradation of aquatic resources

Response interventions from the community perspective: aquatic resources	Ratings					
	0-none	1-very low	2-low	3-average	4-high	5- very high
1.Economic incentives	169					
1.1. Transferring rights to own and manage resources to private individuals gives them a stake in conserving	97	12	33	27		
2. Awareness raising		8	80	77	4	
3. Training workshops			88	56	2	
4. Governance						
4.1. Supportive laws and policies	33	89	13	34		
4.2 Provision of security of tenure	97	11	34	27		
4.3 Devolving authority to lower levels	98	10	34	27		
4.4. Institutional capacity building	37	87		45		
4.5 Responsive local and government authorities	120	30	11	8		
4.6 Traditional rules enforced by the elders	130	12	13	14		
4.7 Punitive measures (penalizing /disciplinary)	156	4	6			
5.Rehabilitation/restoration	87	9	73			
6. Campaigns			34	26	109	
7. Regular Monitoring schemes						

Prevention of the detrimental alteration or modification of the aquatic community structure within the Tana delta. Regular and intensified beach patrols and monitoring of turtle data such as nesting and mortalities has been intensified. The Kenya Sea Turtle Conservation Committee

(KESCOM) implemented a project during 2003-2004 to support the development of a community participation strategy for the conservation of sea turtles in the Kipini area. The initiative complemented global efforts in conservation and management of sea turtles. The Kipini project strengthened the capacity of Kipini Community Conservation Group in data collection. In an attempt to address the potential and actual threats to sea turtles emanating from poor/illegal fishing practices and poaching of turtle products, the project also ran an aggressive public awareness and education targeting the fisher folk, school children and other community members and leaders.

5.1.7: Reptiles

On September 10 2008, one of the Kenyan daily newspapers, the Nation reported that t*wo women were killed and a herdsman seriously injured when they were attacked by crocodiles in separate incidents in Tana River District. The women were attacked while fetching water from a crocodile-infested river. The herdsman was attacked while grazing cattle near a lake.*

Remains of an African Rock Python that was the victim of what we suspect to be an intentional fire attack. Source- Kipini Wildlife and Conservancy Sanctuary 2010

Unsustainable collection of crocodile eggs in the river and other wetlands by private crocodile farms from Mombasa.

Response actions to prevent further degradation of crocodiles

Response interventions from the community perspective: reptiles	Ratings					
	0-none	1-very low	2-low	3-average	4-high	5- very high
1.Economic incentives	169					
1.1. Transferring rights to own and manage resources to private individuals gives them a stake in conserving	97	12	33	27		
2. Awareness raising		8	80	77	4	
3. Training workshops			88	56	2	
4. Governance						

4.1. Supportive laws and policies	33	89	13	34		
4.2 Provision of security of tenure	97	11	34	27		
4.3 Devolving authority to lower levels	98	10	34	27		
4.4. Institutional capacity building	37	87		45		
4.5 Responsive local and government authorities	120	30	11	8		
4.6 Traditional rules enforced by the elders	130	12	13	14		
4.7 Punitive measures (penalizing /disciplinary)	156	4	6			
5.Rehabilitation/restoration	87	9	73			
6. Campaigns			34	26	109	
7. Regular Monitoring schemes						

According to the negotiations between the crocodile harvesters and the SSG, it should be done sustainably through the involvement of the SSG during crocodile's eggs collection and pay some fees for the same.

5.2. Prediction on the future changes of the environment and the impacts of climate from the local knowledge and community perspective

5.2.1: Interpretation of what 'climate change' means to the local people (evidence of climate change at the local scale)

Perceptions of climate change at the local level based on semi-structured interviews of N=169

	More/Longer	Stable	Less/Shorter	Do not know
Rainfall				
Rainfall during rainy season	60	5	104	0
Length of rainy season	47	2	120	0
Rainfall intensity	120	0	49	0
Breaks between rainfall in the rainy season	149	0	20	0
Temperatures				
During the dry season	158	0	9	2
During the rainy season	39	0	120	10
During the hot season	130	0	26	13
During the cold season	130	0	26	13
Winds				
Strong winds during the rainy season	138	0	29	2
Length of (time) of strong winds during rainy season	140	0	22	7
Length of (time) of Strong winds during the dry season	159	0	10	0

Rainfall during rainy season-the quantity of rainfall is considered far less that in the past. This manifests itself in the dry river beds, which are now a common sight.

Length of rainy season –the perceptions held by a majority of the respondents is that the rainfall seasons are much shorter- the rains start late and end much earlier than expected. The delay in the start of the rainy season negatively impacts on the traditionally practiced routines- such as planting of crops, especially maize and there is also less fodder for the livestock.

Unusual weather patterns- The respondents were of the opinion that the climate of the area has definitely changed over the past 5-10 years. The amount of precipitation (both rainfall) has reduced substantially. There has hardly been any snowfall since 2004. Additionally, precipitation (rain) predictability, frequency and extent have also undergone a change. People also referred to certain erratic weather events, especially the replacement of snowfall with rainfall, in winters. Some pointed out that the climatic condition has become very variable. There has also been a change in occurrence of floods, though the change is varied across villages. The reason for the variance was attributed to erratic weather conditions and rainfall, as well as loose soil (due to arid conditions), causing floods. Floods that seemed to be a constant feature in the past have been significantly reduced in the Lower Tana Delta (hence disappearance of some ox – bow lakes).

Rainfall intensity-in areas such as the Tana Delta- Kipini/Ozi and Didawaride and Lake Moa large number of respondents seemed to appreciate the heavy rains that result in floods. The numerous wetlands scattered in the Lower Tana Delta benefit from the floods- for example long after the rains have stopped the livestock herders would still be able to water their livestock in the wetlands. These areas also serve as important grazing areas.

Temperatures- The respondents indicated that the temperatures are now excessive during the hot season and the cold season- in the past considered normal- the temperatures are sometime too low. The general perception was that there has been an increase in mean temperature. Residents felt that warmer temperature is exacerbating the risk of droughts (from land surface drying) and floods (from increased water vapor). In general, minimum temperature for winter and maximum temperature for summer is increasing. Winter season has become milder and shorter, and summer is now considerably warmer.

The study revealed that the perceptions of the local communities about climate change reflect a principle interest in weather elements that influence the abundance and quality of grazing for their livestock, the diminishing water resources in the lakes, dams and ponds, the long dry spells and the unexplained shorter rainy seasons (delays), thus a change in seasons. The intensity and timings of the rains are a key factor. Other elements of climate change as known by the scientist did not feature that much. Despite the challenges that exist of trying to recall something that occurred many years ago, the local people were able to narrate the events that remained ingrained in their minds for a period of 30-40 years.

Changes in Water Supply and Watering Point

The impact of the reduced rainfall has been water scarcity, disappearance of natural springs and drying of pan dams. Pastoralists have had to cover up to 30kms to get water.

Changes in the quantity and quality of grass

There has also been loss of grass, and hence fewer animals in the bomas. This has led to less milk and less food production on farms. The animals do not fetch the same price as before

since they are thin and sick. The price of a bull has declined from between KES. 8,000 and 10,000 to the current KES. 5,000. In response livestock keepers have been moving their animals south.

Change in quality, location and altitude of pasture sites

Changes in Agricultural Landscapes and Food Security
In recent times climate variability and change have forced most pastoralist communities to be sedentary and adopting small scale cultivation. A pastoralist hardly cultivates 5 acres of farmland per season. Productivity is poor due to weather unreliability, poor soils, small farm plots and poor agricultural practices. Only 5% of the respondents indicated that the yields enabled them to have food throughout the year.

Changing Land Tenure & Land Use
Fragmentation & individuation of communal grazing land. Cropping in previously grazing areas. Some abandonment of fields due to failure of short rains and unreliability of the long rains.

What can happen to biodiversity in the future i.e. in the next 20 years?: N=169

	Likely changes that can take place	Very likely-4	likely-3	Less likely-2	None at all-1
Water	Intense winds as more vegetation is cleared for domestic and commercial use	130	39	0	0
	With the increases in surface air temperature, acute shortage of water resources is expected	140	29	0	0
	Reduction in the size of the wetland and water availability will decrease	147	22	0	0
Plants	New patterns of runoff and evaporation will affect natural ecosystems;	130	20	12	7
	Reduced water supplies will place additional stress on people, agriculture and environment	133	36	0	0
	Intense Conflicts over water resources could be sparked by the additional pressures	133	36	0	0
	There is risk of increased number of more flood associated intense hazards i.e. human and livestock deaths	54	101	0	14
	Altered river flow and changes to sediment	130	20	12	7

	Higher water temperatures and changes in the timing, intensity, and duration of precipitation can affect water quality'	130	30	0	6
	Range of many plants may be pushed to higher elevations- in the mountains	97	10	9	53
	Change in phenology (life-cycle events - flowering, egg-laying, migration);	137	25	3	4
	There may be changes in growth of plants i.e. stunted growth	145	15	7	2
	Deforestation may damage land quality	67	98	4	0
	There may be high risk of increased forest fires as the land will be drier	152	9	5	3
Fish	Reduced numbers of fish as harvesting methods become sophisticated	98	44	27	
Mammals	Changes in distribution and abundance of species	140	29	0	0
	Some animal species may shift relocate;	140	29	0	0
	Some animals will not be able to move and may become extinct due to their inability to adapt to rapidly changing climate and habitat conditions;	75	13	5	76
Birds	Reduced numbers of birds	120	40	0	9
	Threat to long distance migrants is feared	98	58	0	13
	staging, resting, nesting and feeding ground for resident and migratory water birds significantly reduced				

What can happen to biodiversity in the future i.e. in the next 20 years? N=169

	Increase 	Decrease 	No change 
Water quantity	46	120	3
Water quality	9	130	20
Plants		169	
Grasslands		169	
Fish	44	98	27
Mammals	29	140	0
Birds	40	120	0

5.3 Develop suitable community-based Pressure-State-Response (PSR) indicators that are amenable to practical implementation at the local level

The identification, selection, and monitoring of indicators is one way in which communities can gather the information to support their diagnostic needs and to support the development of potential response strategies. The indicators have been listed according to the various resource user groups as well as according to the biodiversity features that the community consider important and most relevant to them. An attempt will be made to classify the indicators in a manner suggested by Walpole et.al (2009). The authors suggest a set of (interlinked) headline indicators along the DPSIR with the identification of the four focal areas of Pressures-Threats, Status-Trends, Benefits-Services and Actions-Responses. In arguing the case for the use of a DPSIR framework for biodiversity indicator selection, Niemeijer and de Groot (2008) present three adaptations of this methodology, differing mainly in the number of elements in the causal chain (Teelucksingh S.S and Perrings C (2010).

The study also considered the indicators for which information will be readily accessible and could be obtained with the engagement of the local community, interpreted and understood and meaningful to the local people.

	Perceived indicators			
	State	Pressure	Response	Selected indicator
Water supplies	Decrease in the flooding regime due to water diversion and siltation	water diversion/excessive abstraction upstream and siltation	Appropriate flooding regimes maintained by establishing and enforcing strict upper limits	Appropriate flooding regimes maintained by establishing and enforcing strict upper limits
	Polluted waters	Agro- chemicals as well as pesticides that are extensively used in the farms	Reduced pollution of water sources by pesticides	Incidences of water pollution from agro-chemicals reduced
			Increased number of farmers engaged in organic farming	Number of farmers engaged in organic farming increase
			restricting access by livestock to certain points on the river and the lake	At Lake Moa, reduced incidences of water borne/skin diseases amongst communities directly accessing water for domestic use
Birds	Reduced numbers of bird species: cisticola	Abandonment of the traditional rice farms, which were critical habitat for the numbers of the cisticola	Revamp of the traditional rice farms	Increased number of revamped traditional rice farms
				Number of local residents engaged in traditional rice farming
	Destruction of habitat for birds- reduced wetlands and tree cover	Over-abstraction, siltation	Re-afforestation programmes	Increased number of bird species observed in each monitoring season

		Spraying of birds with chemicals	Strict enforcement	Reduced numbers of bird casualties due to spraying
Fish Fish, prawns, shells, lobsters	Fisheries have declined due to over-overfishing, illegal fishing, by- catch Bottom trawling , and it is becoming harder and harder to land a full catch	Inappropriate gear used	Frequent and regular use of appropriate fishing gear	Number of fishermen using appropriate fishing gear
				Records of inappropriate gear observed or confiscated
				Quotas set and observed per season/per fisherman
				Reduced cases of trawling
				The amount of time at which fish can be caught reduced
	At Kipini and Ozi, species like mud fish, cat fish and the labeos have become rare species attributed	Low breeding rates due to reduced floods. Prolonged droughts therefore limit the fish breeding rates.	Appropriate flooding regimes maintained	Increased numbers of the mud fish, cat fish and the labeos at Kipini and Ozi
				Increase in the number of fingerlings
	Breeding areas interfered with	Destruction of breeding areas	Safeguarding breeding areas	Increase in the number of breeding areas
				Records of disturbances to breeding areas reduced
	At Lake Moa, the major challenge to the fishing industry is the pollution of the water sources.	pollution of the water sources	Safeguard water resources	Increased records of the fish species and numbers
				Reduced numbers of fish deaths due to unexplained reasons
	Fish catch still continues to decline and species like mud fish, cat fish and the labeos have become rare species.	attributed by low breeding rates due to reduced floods	Fish farming introduced	Records of mud fish, cat fish and the labeos
	At Lake Moa, the major challenge to the fishing industry is the pollution of the water sources.	Disposal of sewage, solid waste into Lake Moa	Reduced incidences of pollution	Number of household with appropriate sanitary facilities
Wildlife	Decline in numbers of wild animals	Poaching /illegal hunting of wildlife	Increased records of animals sighted	Records of wildlife sighted
	Destroyed crocodile	Unsustainable	Records of undisturbed	Records of

	eggs	collection of crocodile eggs in the river and other wetlands by private crocodile farms from Mombasa.	crocodile breeding areas increase	undisturbed crocodile breeding areas increase
Plant	Reduced numbers of forest patches/trees	Destruction of woodland	Strict enforcement of regulations. Advocate legalizing commercial utilisation through unrestricted access as the first step towards control and management. Laws must then change. Education and training, grants and loans will all help too. Increase number of medicinal plant species	Surface area without trees or scanty number of trees decreases
				Records of felled trees reduced
	Reduced coverage of mangroves	Overharvesting of mangroves	Strict enforcement of regulations	Reduced records of harvested/ felled mangrove trees
			Re-afforestation of mangroves	Increase in the density of mangrove trees
	Excessive cutting of trees/decimation of forests- patches of forests have been rapidly disappearing		Reduced disturbances to patches of forests and also to repair the riparian zone by planting trees and grasses to stablise shorelines and provide habitats.	
Grasslands	Overgrazing resulting in poor livestock yields	Increased/ uncontrolled numbers of livestock into the grazing areas	Observance of	Numbers of livestock
	disruption traditional patterns of transhumance	Excessive numbers of livestock		traditional patterns of transhumance restored
	intensified conflict between pastoralists and floodplain residents	Excessive numbers of livestock		Reduced incidences of conflict between pastoralists and floodplain residents
	Milk production had declined tremendously since pasture regeneration and growth was very poor.		Reduced conflicts between pastoralists and agriculturalists	Increased milk yields
	The remaining			Reduced livestock

	livestock in the villages starved resulting to many cases of livestock deaths, as carcasses could be seen			deaths
Turtles	Reduced/endangered species	Illegal harvesting of turtles	Enforcement of rules and regulations/ awareness	Reduced incidences of turtles harvested by both the local and foreign fishermen
	Destruction of breeding areas for turtles		Regular and intensified beach patrols and monitoring of turtle data such as nesting and mortalities has been intensified	

Ratings in terms of significance at the local scale

Selected indicator	Ratings in terms of significance at the local scale		
	1-very significant	2-Less significant	Do not know
Appropriate flooding regimes maintained by establishing and enforcing strict upper limits	169		
Incidences of water pollution from agro-chemicals reduced	140	29	
Number of farmers engaged in organic farming increase	156	13	
At Lake Moa, reduced incidences of water borne/skin diseases amongst communities directly accessing water for domestic use	42		
Increased number of revamped traditional rice farms	120	49	
Number of local residents engaged in traditional rice farming	120	49	
Increased number of bird species observed in each monitoring season	149	20	
Reduced numbers of bird casualties due to spraying	76	93	
Number of fishermen using appropriate fishing gear	87	82	
Records of inappropriate gear observed or confiscated	134	35	
Quotas set and observed per season/per fisherman	150	10	
Reduced cases of trawling	9	90	70
The amount of time at which fish can be caught reduced	134	35	
Increased numbers of the mud fish, cat fish and the labeos at Kipini and Ozi	120		
Increase in the number of fingerlings	120		
Increase in the number of breeding areas	120		
Records of disturbances to breeding areas reduced	120		
Increased records of the fish species and numbers	120		
Reduced numbers of fish deaths due to unexplained reasons	42		
Records of mud fish, cat fish and the labeos	120		
Number of household with appropriate sanitary facilities	42		
Records of wildlife sighted	136		
Records of undisturbed crocodile breeding areas increase	2	167	
Surface area without trees or scanty number of trees decreases	121	48	

Records of felled trees reduced	143		
Reduced records of harvested/felled mangrove trees	43		
Increase in the density of mangrove trees			
Numbers of livestock	120		
Traditional patterns of transhumance restored	45		
Reduced incidences of conflict between pastoralists and floodplain residents	134		
Increased milk yields	169		
Reduced livestock deaths	169		
Reduced incidences of turtles harvested by both the local and foreign fishermen	90		

Possible means of monitoring the indicator

Selected indicator	Possible means of monitoring the indicator at the local scale	Monitoring of the selected indicator at the local scale		
		1-very practical	2-Less practical	Do not know
Appropriate flooding regimes maintained by establishing and enforcing strict upper limits	Direct observance by the local community and indicating markings of the flooding regimes per season	27	142	
Incidences of water pollution from agro-chemicals reduced		29	140	
Number of farmers engaged in organic farming increase	Records of local residents engaged in organic farming	156	13	
At Lake Moa, reduced incidences of water borne/skin diseases amongst communities directly accessing water for domestic use	Records of incidences of water borne/skin diseases at the local health facility	42		
Increased number of revamped traditional rice farms	Count of farms where traditional rice farming is being practiced	120	49	
Number of local residents engaged in traditional rice farming	Records of local residents engaged in traditional rice farming	120	49	
Increased number of bird species observed in each monitoring season	Regular IBA Monitoring/annual water fowl census	149	20	
Reduced numbers of bird casualties due to spraying	Regular IBA Monitoring/annual water fowl census	76	93	
Number of fishermen using appropriate fishing gear	Direct observation	87	82	
Records of inappropriate gear observed or confiscated	Direct observation and records	134	35	
Quotas set and observed per season/per fisherman	The type of systematically collected information required would include	150	10	

	recording of all fishers and crews not members of local BMUs, their origin, time of arrival, gears used, species and quantities landed. This could be collected by BMUs in collaboration with, and with the support from the Fisheries Department.			
Reduced cases of trawling	Direct observation and records	9	90	70
The amount of time at which fish can be caught reduced	Fish catch per unit effort	134	35	
Increased numbers of the mud fish, cat fish and the labeos at Kipini and Ozi	Records of the mud fish, cat fish and the labeos at Kipini and Ozi	120		
Increase in the number of fingerlings	Records of the fingerlings	120		
Increase in the number of breeding areas	Records of the breeding areas	120		
Records of disturbances to breeding areas reduced	Records of the breeding areas	120		
Increased records of the fish species and numbers	Regular onshore observations and interviews with fishermen both during wet/season.	120		
	Better monitoring of migrant fishers (both Kenyan and non-Kenyan) at landing sites is a prerequisite for improved understanding of fishers' movements and the effects of such mobility on coastal resources. The type of systematically collected information required would include recording of all fishers and crews not members of local BMUs, their origin, time of arrival, gears used, species and quantities landed. This could be collected by BMUs in collaboration with, and with the support from the Fisheries Department.	87		
Reduced numbers of fish deaths due to unexplained reasons	Records of fish deaths per season	42		
Records of mud fish, cat fish and the labeos	Records of mud fish, cat fish and the labeos	120		
Number of Records of mud fish, cat fish and the labeos	Records of mud fish, cat fish and the labeos	42		
Records of carcasses reduced Records of wildlife sighted	Records of carcasses Quarterly animal counts Identification of animal tracks	136		
Records of undisturbed crocodile breeding areas increase	Records	2	167	
Surface area without trees or	Regular transects recording surface area	121	48	

scanty number of trees decreases				
Records of felled trees reduced	Records of mud fish, cat fish and the labeos	143		
Reduced records of harvested/ felled mangrove trees	Records of mud fish, cat fish and the labeos	43		
Increase in the density of mangrove trees	Regular transects recording surface area			
traditional patterns of transhumance restored	Direct observance of patterns	45		
Reduced incidences of conflict between pastoralists and floodplain residents	Records at the traditional leaders office/local authority	134		
Increased milk yields	Records of milk yield discussed by the local community	169		
Reduced livestock deaths	Records of livestock deaths	169		
Reduced incidences of turtles harvested by both the local and foreign fishermen	Regular monitoring of the turtles and the breeding sites Regular monitoring of the turtles and the breeding sites	90		

CHAPTER 6: DISCUSSION OF FINDINGS

The most common standards used to assess water quality at all study sites relate to what the community considers to be the critical uses for the resource to them: Mainly, livestock watering; drinking water; health of ecosystems- in relation to provision and sustenance of aquatic resources –especially fish and safety of human contact featured the most. Surface water is usually the main source of water for purely pastoral livestock in semi- arid regions. During the rainy season, precipitation over limited catchment basins runs off and concentrates in natural ponds where the soils are sufficiently impervious to prevent leaking. Most of these ponds dry out after the end of the rainy season due to the combined effect of evaporation and seepage. During the dry season, livestock move towards the permanent surfaces of water such as large rivers, lakes or ponds. This method of utilisation of surface water only requires leading of herds and is preferred by herders compared to ground water. Sanding up of ponds decreases their storage capacity until it becomes negligible so that the actual number of usable ponds is smaller every year. This phenomenon is aggravated by overgrazing and resulting desertification which makes the upper layer of the soil more sensitive to the wind and erosion. The remoteness and the uneven distribution of the permanent lakes and rivers during the dry season results in the overgrazing of pasture land surrounding the water supplies. Moreover agricultural land grows to the detriment of the rangelands which become smaller while the livestock tends to grow every year.

The term wetland apparently not clearly defined and understood, to them wetlands are 'swamps' = sawaiti and marshes 'njobi'. Rivers and lakes do not appear significant in their definition though highly valued. The wetlands are based on functional roles particularly its importance in the socio economic cultural set up.

The condition of biodiversity in the past- at least 40 years ago was generally said to have been in good state. There was abundance of resources as the levels of utilization were not at the scale that they are in the present day. There were strict customary regulations, taboos, customs that were enforced and observed to the benefit of all the inhabitants. The state of biodiversity as of present is largely perceived as undesirable, in bad state and at levels that are not meeting the demands of the ever increasing population. A diverse number of factors have contributed to the present condition of biodiversity. If the threats on biodiversity continue unabated, the future does not look promising. The local communities acknowledge that if a desirable state is to be attained, a concerted effort needs to be made by all parties. The intervention mechanisms should however not be at the detriment of the local people, who have traditionally relied on the resources.

Indigenous peoples interpret climate change in various ways. Their interpretation depends on personal observations, experiences and local cultural framework. "While scientific explanations of climate changes have mainly concentrated on anthropogenic, greenhouse gas emissions, local interpretations of observed climate changes are often much more varied and encompassing" (Salick and Byg, 2007:17). Some people consider adverse weather conditions as punishments for wrongdoings that have been committed by humans. They identified various spiritual and social causes of climate change. Spiritual explanations of climate change are incompatible with scientific explanation. During the conduct of the study, it was obvious that trend was emerging – the local peoples' perception about climate change has scientific

elements. The residents were aware that lack of trees can lead to drought. Modern science also confirms that trees can absorb excess carbon dioxide. Like peasant farmers, scientists use combination of observed soil water conditions and river levels to estimate flood risk. They also use observations of soil moisture and plant conditions to estimate drought risk (Basher and Briceňo, 2005:274). Moving out of their normal migration orbits in search of pasture. They also employ a strategy of following the rains- without many belongings. The study confirmed that the local people who the custodians and users of the resources have the ability to observe climatic changes and their biophysical impacts at smaller spatial scales and in greater detail

The study has helped to enhance understanding of critical linkages between environment and human activities, especially from the local community perspective as the locals have a good understanding of the links. What has been discussed so far shows that the resource users as the custodians of biodiversity are not blind followers of nature. They have attempted to understand the secret of nature and avoid famine, war and other problems by employing different strategies. They have tried to discover the unknown and the future by considering the reactions of plants, animals and the natural environment to both humanly induced change and natural change. People are trying to evolve, construct new lives. Within three to four generations lifestyles and livelihoods have changed, new knowledge is learnt from schooling and experience. Traditional knowledge and values become obsolete and tribal identity is subsumed into a hybrid way of living. The major goal of this effort is to maintain a positive relationship with the natural environment.

Indigenous mechanisms are not sufficient by themselves to deal with the effects of climate change. They should be complemented by modern strategies. This study, thus, suggests that policy makers, modern scientists and peasant farmers have to work together to address the adverse effects of climate change. This is where the 'transdisciplinary methodology 'as proposed by (McGregor 2009b) as outlined in the earlier chapter comes into play- the multiple layers of reality have to interact with each other for tangible solutions to be found.

The local communities identified and selected a set of community-based Pressure-State-Response (PSR) indicators that are amenable to practical implementation at the local level. The major determining factors to them were the relevancy and the applicability of the indicator-whether with community effort the indicator can be monitored, whether the indicator was responsive/relevant to the needs of the communities as they perceive them. The study was cognizant of the fact that indicators selected by the community need to be issue-specific and must be presented in a way that makes the information they generate easy to understand and useful in making decisions about climate change and health impacts at the community level. The study first of all determined the key end users. The indicators identified by the local community reflect a close connection between the wetlands/resources and the livelihoods of the people dependent on them.

Also, soil erosion control in overgrazed semi-arid parts of the Tana Basin through de-stocking has never been attempted due to perceived resistance from pastoral communities who traditionally prefer to keep huge herds of cattle as a repository of wealth, source of pride and daily livelihood.

CHAPTER 7: CONCLUSION

The study has addressed the three specific objectives by analyzing and documenting the current state of environment (SoE) for the selected wetland IBAs site, predicted the future changes of the environment and the impacts of climate from the local knowledge and community perspective and developed suitable community-based Pressure-State-Response (PSR) indicators that are amenable to practical implementation at the local level. The study investigated the perceptions of the local communities essentially about how nature used to be, how nature is at present and the envisaged state of nature in the future. The study looked at the variables such as quality and quantity of water, mammals aquatic and plant/vegetation resources.

Local people demonstrate high level of knowledge of the weather patterns and provided a clear account of the multiple indicators. This could be attributed to the interlinkage between man and nature as well as the spatial scale. The variables presented by the local communities focus on extreme events- that have remained ingrained in their memory.

The study has shown that local environmental knowledge of biodiversity resource dependent communities is critical for developing indicators that can be well interpreted, understood and used.

REFERENCES

Books

Adriaanse, A. (1993): Environmental Policy Performance Indicators. The Hague: Ministry of Housing, Physical Planning and Environment.

Baillie J (2006): Global biodiversity indicators: Institute of Zoology, Imperial College, London

Bakkes, J.A., Van den Born, G.J., Swart, R.J., Hope, C.W. and Parker, J.D.E. (1994): An Overview of Environmental Indicators: State of the Art and Perspectives, UNEP/EATR.04-01; Environmental Assessment Sub-Programme, UNEP, Nairobi.

Balmford A (2002): Selecting sites for conservation. In: Norris K, Pain D.J, editors. *Conserving bird biodiversity- general principles and their application.* Cambridge University Press; pp. 74–104.

Basso, K.H (1996): Wisdom sits in places: landscape and Language among the Western Apache. University of New Mexico Press, Albuquerque

Bennun L and Njoronge P (1999): Important Bird Areas of Kenya, Ornithology Department, National Museums of Kenya

Berkes F. (1989): Common property resources, Ecology and Community- based sustainable development. Belhaven Press, London

Berkes F. (1993): Traditional ecological knowledge in Perspective

Berlin B. (1992): Ethno-biological classification: Principles of Categorisation of Plants and Animals in Traditional Societies. Princeton University Press, Princeton, New Jersey
Bhattaria T (not dated): Process and Methods for Participatory M&E of Biodiversity: A Southern Reconnaissance

Bibby C.J (1999): Making the most of birds as environmental indicators. *Ostrich.*70:81–88.

Bibby C.J, Burgess N.D, Hill D.A, Mustoe S. (2000): 2nd edn. Academic Press; London: Birds census techniques.

Biehorst, J. (1994): The way of the earth: Native America and the Environment. William Marrow &Co, New York

Biodiversity Indicators Partnership Workshop Report (2008): Caribbean Biodiversity Indicators Capacity Development Workshop

BirdLife International (1996): Important Bird Area Fact Sheet

BirdLife International/European Bird Census Council (2000), *European bird populations: estimates and trends*-BirdLife Conservation Series No. 10. Cambridge: BirdLife International.

BirdLife International (2009), Important Bird Area factsheet:

Boothroyd I, K, G (not dated), Sustainable resource management: A Pressure-State-Response framework for sustainability in the urban environment, Kingett Mitchell Ltd, Takapuna, Auckland;

Boyle, M (1998): Developing policy performance indicators for Ontario Ministry, of Natural Resources. M.Sc. thesis, University of Waterloo, Canada

Brann J (2007): Terminal Evaluation of the project 'Biodiversity Indicators for National Use (BINU)' Project No: GF/1020-02-01 Evaluation and Oversight Unit
Chambers, Robert. (1992): Rural Appraisal; Rapid, Relaxed and Participatory, Discussion Paper 311, University of Sussex

Crafter SA, Njuguna SG and Howard GW: (not dated), Wetlands of Kenya, Proceedings of a Seminar on Wetlands of Kenya, The IUCN Wetlands Programme

CBD (not dated): Developing indicators for national-level monitoring of biodiversity
CBD (2002), CBD/COP6 Decision VI/26: Strategic Plan for the Convention on Biological Diversity

Department of Urban Affairs and Planning (2001), *Check Your Success: A Guide to Developing Indicators for Community Based Environmental Projects*, Graduate Environmental Studio Project, Virginia Tech, Blacksburg, VA

Doubleday N.C (1993): Finding common grounds: Natural law and collective wisdom in

Dumanski J (1994): *Application of the pressure-state-response framework for the land quality indicators (LQI) programme*-World Bank, Washington D.C., USA)

Fishpool & Evans (2001): *Important Bird Areas in Africa and associated islands*, Pisces Publications and BirdLife International

Furness R.W, Greenwood J.J.D (1993): *Birds as monitors of environmental change.* Chapman & Hall; London

Gadgil M, Berkes F. (1991): Traditional Resource Management Systems'. Resource Management Optimisation

Geheb, K. 1996. *The Regulators and the Regulated: Fisheries Management, Options and Dynamics in Kenya.s Lake Victoria Fishery*. Ph.D. Dissertation. School of African and Asian Studies, University of Sussex. UK.

Geheb K. 1997. The regulators and the regulated: Fisheries management, dynamics and options in Kenya's Lake Victoria fishery. PhD dissertation. University of Sussex, United Kingdom.

Government of the Republic of Kenya (2007): Kenya Vision 2030- The Popular Version
Harrison P and Pearson F, American Association for the Advancement of Science, University of California Press

Gregory RD, Arco van Strien, Vorisek P, Meyling AWG, Noble DG, and Ruud P.B Foppen, Gibbons DW (2005): Developing indicators for European birds (2005): The Royal Society

Hockings, Marc with Sue Stolton and Nigel Dudley (2000): *Assessing Effectiveness – A Framework for Assessing Management Effectiveness of Protected Areas*; University of Cardiff and IUCN, Switzerland.

Holdgate, M. (1996): From care to action; making a sustainable world. London, UK, World Conservation Union (IUCN) and Earthscan

Inglis J.T (ed) Traditional Ecological Knowledge: Concepts and Cases. International Development Research Centre, Canada

IUCN, (2000): Red List of Threatened Species, International Union for the Conservation of nature and Natural Resources, Gland, Switzerland

Jackson, L.E, Kurtz, J.C. & Fisher, W.S (2000): Evaluation Guidelines for Ecological Indicators. EPA/620/R-99/005. US Environmental Protection Agency, Office of Research and Development, Research Triangle Park, North Carolina, USA

Kalland, A. (1994): Indigenous local knowledge: prospects and limitations

Kamstra, J. (1994): Protected Areas: Towards a Participatory Approach, Committee for the International Union for the Conservation of Nature and NOVIB, Amsterdam, Netherlands

Larsson, T, B. & Esteban, J.A. (eds.) (2000)*: Cost-effective indicators to assess biological diversity in the framework of the Convention on Biological Diversity – CBD, Stockholm, Sweden*

Lees and Peres (2008):

Martin C. (1978): Keepers of the Game. University of California Press, Berkeley
Martin and Possingham (2005):

Markussen, M. NIBR Working Paper: 2002:115Women in the informal fish processing and marketing sectors of Lake Victoria

Newton, A.C. and Kapos V. (not dated): Biodiversity indicators in national forest inventories, UNEP World Conservation Monitoring Centre, Cambridge, United Kingdom.

Njuguna, S.G. (1995): Conservation of biodiversity in Africa: Local initiatives and institutional roles

Pasiecznik (2001):
Philips (1936):-fires

Pimbert, M. and Ghimire, K.B. (1995): Social Change and Conservation, United Nations Research Institute for Social Development

Pisupati, B and Warner, E. (2003): Biodiversity and the Millennium Development Goals, IUCN, Colombo

Popotnik and Giuliano, 2000):
Posey, D.A and Dutfield, G (1997): Indigenous Peoples and Sustainability: cases and actions, IUCN Inter-Commission Task Force on Indigenous Peoples. International Books. Utrecht.240-254

Posey, D.A (1999): Cultural and Spiritual Values of biodiversity, United Nations Environment Programme, Kenya

Primack, R.B (1983): Essentials of Conservation biology, Sinauer Associates Sutherland Massachusetts, USA

Pyne 2001):fires

Reid W.V., McNeely J.A., Tunstall D.B., Bryant D.A. & Winograd M. (1993): Biodiversity indicators for policy-makers. World Resources Institute, Washington, D.C.

Rigby, D., Howlett, D. and Woodhouse, P. (2000): Sustainability indicators for natural resource management and policy: A review of indicators of agricultural and rural livelihood sustainability.

Sue Stolton and Nigel Dudley, Equilibrium Consultants (not dated): Assessing Management Effectiveness of Natural World Heritage Sites
Towards Sustainable Development: Environmental Indicators (1998): Organization for Economic Cooperation & Development

UNEP (2005): Biodiversity Indicators for National Use Project, Kenya, National Project Experience Report, Part 2

UNEP/CBD/SBSTTA/9/INF/7 (2003): Report of the expert meeting on indicators of biological diversity including indicators for rapid assessment of inland water ecosystems. Convention on Biological Diversity, Montreal, 10-14 February 2003.

UNHCR (1982): Handbook for emergencies, part one: Field operations, UNHCR, Geneva, 1982.

Wallner A, (not dated) Local people's perceptions of protected areas: a cross-cultural study. Swiss Federal Research Institute WSL, Zuercherstrasse 111, 8903 Birmensdorf, Switzerland

Wells, M.et al, (1992): People and Parks: Linking Protected Areas Management with local communities, World Bank, WWF, USA Agency for International Development, Washington DC

World Commission on Environment and Development, (1998): Our Common Future, Oxford and New York, Oxford University Press

World Resources Institute, (1995): Environmental Indicators: A systematic Approach to Measuring and reporting on Environmental Policy Performance in the Context of Sustainable Development.

WWF, (2000): The root causes of biodiversity loss, Macro- economic for Sustainable Development Program Office, WWF International

Journals

Acharya, U., Petheram R. J., and Reid R. (2005), Forestry chronicle, Volume 81, Biodiversity conservation: officials' perceptions and discord with community forest management in Nepal

Alcorn J. B (1994): Noble savages or Noble State?: Northern Myths and Southern Realities in Biodiversity Conservation. In: Toledo, V.M.E (ed) Ethno ecological Vol 11 No 3 April

Alves et al (2005): Environmental perception of gatherers of the crab affecting their collection attitudes, Journal of Ethnobiology and Ethnomedicine

Haile G, Assen M and Ebro A 2010:Land use/Cover dynamics and its implications since the 1960s in the Borana rangelands of Southern Ethiopia. *Livestock Research for Rural Development. Volume 22, Article #132.* Retrieved July 29, 2011, from http://www.lrrd.org/lrrd22/7/hail22132.htm

Ayoo C. (2007): Community Based Natural Resources Management in Kenya, Management of Environmental Quality. An International Journal pg 531-541

Balirwa J.S, et al (2003): Biodiversity and Fishery Sustainability in the Lake Victoria Basin: An Unexpected Marriage?, *August 2003 / Vol. 53 No. 8* . BioScience 703

Failing and Gregory (2009): in Volume 68, Issue 2 of the Journal on Environmental Management

Cairncross, S. and Kinnear, J. (1992): "Elasticity of demand for water in Khartoum, Sudan", Soc. Sci. Med. 34; 2, 1992, pp. 183-89.

Clad J. (1984): Conservation and Indigenous Peoples: A study of convergent interests. Cultural Survival Quarterly 8: 68-73

Gilman, R.H. et al. (1993): " Water cost and availability: Key determinants of family hygiene in a Peruvian shantytown ", A.J.P.H. 83, 1993, pp. 1554-58.

Gleick, P. (1996): Basic water requirements for human activities: meeting basic needs. Water International 21:83-92.

Green R.E, et al (2005): A framework for improved monitoring of biodiversity: responses to the World Summit on Sustainable Development. *Conserv. Biol.*; 19:56–65.

Gregory R.D, Noble D, Field R, Marchant J.H, Raven M, Gibbons D.W. *(*2003): Using birds as indicators of biodiversity. *Ornis Hungarica.*; 12–13:11–24.

Goldschmidt T,Witte F,Wanink J,H.(1993): Cascading effects of the introduced Nile perch on the detritivorous/phytoplanktivorous species in the sublittoral areas of Lake Victoria. Conservation Biology 7: 686–700.

Goudswaard K,Witte F,Chapman LJ. (2002b): Decline of the African lungfish *(Protopterus aethiopicus)* in Lake Victoria (East Africa). Journal of African Ecology 40: 42–52.

Hilty J, Merenlender A (2000): Faunal indicator taxa selection for monitoring ecosystem health. *Biol. Conserv.*; 92:185–197.

Hughey, K. F. D., Cullen, R., Kerr, G. N., Cook, A. J. (2004): Application of the pressure-state – response framework to perceptions reporting of the state of the New Zealand environment. Journal of Environmental Management 70: 85-93.

Hukkinen,J.(2003): Sustainability indicators for anticipating the fickleness of human-environmental interaction, Journal on Clean Technologies and Environmental policy, Volume 5, Numbers 3-4

Hyman, J.B. & Leibowitz, S.G. (2001): JSEM: a framework for identifying and evaluating indicators. *Environmental Monitoring and Assessment*, 66: 207-232.

Landres P.H, Verner J, Thomas J.W. (1988): Ecological uses of vertebrate indicator species—a critique. *Conserv. Biol.*; 2:316–328.

Levrel, H.et al, (2009): OECD Pressure- State- Response Indicators for managing biodiversity: a realistic perspective for a French Biosphere Reserve, Biodiversity and Conservation, Volume 18, Number 7, pg 1710-1732

Marin A (2010): Riders under storms: Contributions of nomadic herder' observers to analyzing climate change in Mongolia inEakin H and Lemos M.C (2010): Global Environmental Change- Human Dimensions, Volume 20 Number 1 February 2010, Elsevier Ltd, Henry Ling Ltd, The Dorset Press, Dorchester, UK

Nielsen, J.O and Reenberg A (2010): Cultural barriers to climate change adaptation: A case study from Northern Burkina Faso in Eakin H and Lemos M.C (2010): Global Environmental Change- Human Dimensions, Volume 20 Number 1 February 2010, Elsevier Ltd, Henry Ling Ltd, The Dorset Press, Dorchester, UK

Noss, R.F. (1990): Indicators for monitoring biodiversity: a hierarchical approach. *Conservation Biology*, 4(4): 355-364.

Noss, R.F. (1999): Assessing and monitoring forest biodiversity: a suggested framework and indicators. *Forest Ecology and Management*, 115: 135-146.

Owino, A and Ryan, P. (2007): Wetlands Ecology and Management, Volume 15, Number 1, February 2007, pp. 1-12(12)

Phillips, O and Gentry, A. H (1993): The useful plants of Tambopata, Peru: Statistical Hypothesis Tests with a new quantitative technique. Economic Botany 47 (1): 15-32

Pinendo Vasquez et al (1990): Use- value of tree species in communal forests reserve in north-east Peru; Conservation Biology 4 (4):405-416

Prance et al, (1987): Quantitative ethno botany and for the conservation in Amazonia; Conservation Biology 14: 269-310

Pretty, J and Ward, H. (2001): Social capital and the environment. World Environment 29 (2), 209-227

Redford, K. H and Stearman, A. M (1993): Forest dwelling native Amazonians and the conservation of biodiversity interests in common or collision? Conservation Biology 7 (2): 248-2555

Reinthal, P.N.; Kling, G.W.: Exotic species, trophic interactions, and ecosystem dynamics: A case study of Lake Victoria. Univ. South Carolina Press: COLUMBIA, SC (USA); BELLE W. BARUCH LIBR.MAR. SCI; vol. 18, pp. 295-314; 1994; (Theory and Application of Fish Feeding Ecology; Stouder,D.J.;Fresh, K.L.;Feller, R.J. (eds.).

Ribbink, E.Trewavas, F. Witte and K. Yamoaka (1985): The destruction of fisheries in Africa's lakes. In: Nature. Vol. 315, pp 19-20

Shivakumar, S.J. (2003): The place of indigenous institutions in constitutional order. Constitutional Political Economy 14, 3-21

Smith W, Meredith, T.C and Johns T. (1996): Use and Conservation of woody vegetation by the Batemi of Ngorongoro District, Tanzania. Economic Botany. 50:290-299

Wilson, K.B.(1998a): Trees in fields of Southern Zimbabwe Journal of Southern African Studies 15 (2), pp 369-83

Technical Reports/Workshop reports/Newsletters/Discussion Papers

Biodiversity Indicators Partnership Workshop Report, (2008): Caribbean Biodiversity Indicators Capacity Development Workshop

Bodley (1976): Anthropology and Contemporary Human Problems. Benjamin Cummings Publishing, Menlo Park

Bodeker, G. (1996): Global Health Traditions

Bokea C. & Ikiara M. (2000): .The Macro-Economy of the Export Fishing Industry in Lake Victoria (Kenya)., Report No. 7 in .Socio - Economics of the Lake Victoria Fisheries., IUCN EARO, Eastern Africa Programme.

Bubb P, Jenkins M, Kapos V. (2005): Biodiversity Indicators for National Use: Experience and Guidance UNEP- WCMC, Cambridge, UK

Delbaere, B. (2002: Biodiversity indicators and monitoring: Moving towards implementation. Proceedings of a side event held at CBD/COP6. (ECNC Technical report series). ECNC, Tilburg- The Netherlands/Budapest- Hungary. 35 pp + annexes.

Dixon, AB and Wood, A.P. (2007): Local Institutions for wetland management in Ethiopia: Sustainability and State Intervention Community Based Water Law and Water Resources Management Reform in Developing Countries

Graham M.(1929): The Victoria Nyanza and Its Fisheries: A Report on the Fish Survey of Lake Victoria 1927–1928 and Appendices. London: Crown Agents for the Colonies.

Jansen, E.G. (1997):.*Rich Fisheries- Poor Fisherfolk: Some Preliminary Observations About the Effects of Trade and Aid in The Lake Victoria Fisheries*., Report No. 1 in .Socio-Economics of the Lake Victoria Fisheries., IUCN EARO, Eastern Africa Programme

Jansen, E. G., Abila, R.O. and Owino, J. P. (1999): Constraints and Opportunities for Community Participation. in *the Management of the Lake Victoria Fisheries*., Report No. 6 in .Socio-Economics of the Lake Victoria Fisheries., IUCN EARO, Eastern Africa Programme.

GoK, (2000): National biodiversity Strategy and Action Plan (NBSAP), Kenya

Government of Kenya, (2005b): Draft policy on national wetlands conservation and management, Ministry of Environment and Natural Resources, Kenya

Government of Kenya, (2005d): Sessional Paper on national wetlands conservation and management, Ministry of Environment and Natural Resources, Kenya

Government of Kenya, (2007): Kenya Vision 2030: The National Economic and Social Council of Kenya (NESC), Kenya

Government of Kenya, (2007): Kenya Vision 2030: The Popular Version, Kenya

Intergovernmental Task Force on Monitoring Water Quality Interagency Advisory Committee on Water Data, Water Information Coordination Program, Water-quality monitoring in the United States, technical appendices, final report of the intergovernmental task force on monitoring water quality, 1995 Washington, D.C.

Report of an expert meeting, Stockholm, (1999): Stockholm, Sweden, Swedish Environmental Protection Agency/Ministry of Environment, Government of Catalonia, Barcelona.

Kenya Land Alliance: Land use in Kenya- The case for a National Land Use Policy, Land Reform Volume 3

Kenya Wetlands Forum (2005): Development, Conservation and People's livelihood at crossroads, The Proposed Sugarcane Project in the Tana Delta, Tana River District – Coast Province, Kenya, East Africa Wildlife Society

Maffi, L. (1996): Language, knowledge and the environment: Threats to the world's biocultural diversity. Anthropology Newsletter 38 (2):11

Manek, M. (2001): The implementation of Biodiversity Related Conventions: A Kenyan Case Study, UNEP-BPSP Project

Matiza, T and Crafter, S.A (1994): Wetlands Ecology and Priorities for Conservation in Zimbabwe: Proceedings of a Seminar on Wetlands Ecology and Priorities for Conservation in Zimbabwe, Kentucky Airport Hotel, Harare

Mbugua, G. (2002): An analysis of Kenya's implementation of the Convention on Biological Diversity with a focus on forests, National Environmental Management Agency, Kenya

Ministry of Environment and Natural resources, (2000): A summary of the Kenya National Biodiversity Strategy Action Plan, Kenya

Nabhan G.P (1996): Discussion Paper for the colloquium 'Loosing species, Languages and Stories; Linking cultural and Environmental change in the Bi-national Southwest;' Arizona-Sonora Desert Museum, Tucson, AZ, April 1-3, 1996

National Environmental Management Agency, Kenya (2006): Capacity for development and implementation of general measures in situ and ex-situ conservation and sustainable use of biological diversity in Kenya

National Environmental Management Agency, Kenya (2008): National Environmental Research Agenda, (2008-2030), Government of the Republic of Kenya

Ng'eno, J.K. (1996): Country report to FAO International Technical Conference on Plant Genetic Resources, Leipzig

McCormick, D. 1998. .Enterprise Clusters in Africa: On the Way to Industrialisation?.*IDS Discussion Paper 336*. Institute of Development Studies. University of Nairobi. Nairobi.

Mitullah, W. (1998): .Lake Victoria's Nile Perch Fish Industry. The Politics of Joint Action.. *IDS Working Paper No. 519*. Institute for Development Studies. University of Nairobi, Nairobi.

OECD (1993): OECD Core Set of Indicators for Environmental Performance Reviews. A Synthesis Report by the Group on the State of the Environment. OECD, Paris.

Organization for Economic Co-operation and Development (2003): OECD Environmental Indicators, Development, Measurement and Use, Reference Paper

Pimbert, M P, and Pretty, J N, (1995): 'Parks, people and professionals. Putting "participation" into protected area management', UNRISD-IIED-WWF Discussion Paper, UNRISD No. 57

Stork, N.E., Boyle, T.J.B., Dale, V., Eeley, H., Finegan, B., Lawes, M., Manokaran, N., Prabhu, R. & Soberon, J. (1997): *Criteria and indicators for assessing the sustainability of forest management: conservation of biodiversity*. CIFOR Working Paper No. 17. Jakarta, Indonesia, CIFOR.

Subsidiary Body on Scientific, Technical and Technological Advise- SBSTTA (2003): *Proposed biodiversity indicators relevant to the 2010 target* Montreal: Bureau of Convention of Biological Diversity.

Sahai, S. (undated), The challenge to indigenous people and indigenous culture: An Asian perspective

ten Brink, B. (2003), The state of agro-biodiversity in The Netherlands: integrating habitat and species indicators-Proceedings of OECD expert meeting in 2001 Agriculture and biodiversity. Developing indicators for policy analysis, pp. 264–275. Paris: OECD.

UNEP/CBD/SBSTTA/9/INF/7: (2003): Report on the expert meeting on indicators of biological diversity including indicators for rapid assessment on inland water ecosystems, CBD, Montreal

UNEP, (2005): Biodiversity Indicators for National Use project, Kenya, National Project Experience report part 2

UNEP WCMC, (2010): Are you a green leader- Business and Biodiversity, making the case for a lasting solution

WEHAB Working Group, (2002): A Framework for Action on Biodiversity and Ecosystem Management

Websites

Billig P; Bendahmane D and Swindale A Water and Sanitation Indicators Measurement Guide: (Food and Nutritional Technical Assistance): http://www.fantaproject.org/downloads/pdfs/watsan.pdf

CBD (2004), CBD/COP7 Decision VII/30 - Strategic Plan: future evaluation of progress. http://www.biodiv.org/decisions.

European Environmental Agency, (2003)
http//www.eea.eu.int

Nature Kenya (2008): Brief on Tana River Delta Biodiversity, www. Naturekenya.org

Roberts L (1998): Diminishing standards: How much water do people need? Extract from FORUM: Water and war http://www.icrc.org/eng/resources/documents/misc/57jpl6.htm