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Katharina Deichsel

"Our Lake Is Our Farm": Local Knowledge of Tugen Fishermen on Environmental Changes of Lake Baringo, Kenya

Edited by the Cologne African Studies Centre

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Preface

The ethnography of East Africa has astonishingly little to say about people making their living along the sweet-water lakes of the Rift Valley. While the major lakes, i.e. Lake Victoria, Lake Tanganyika or Lake Malawi perhaps gained some consideration, the smaller sweet-water lakes are almost absent from social-science literature. In the historiography of Kenya and Tanzania these lakes have been depicted as ecological niches and last resort for impoverished and famished populations which lost their herds due to drought or epidemic diseases, who suffered from failed harvests or who had been victims of violence. The options for fishery, a craft that needs little technological input nor does it need any land rights, were good along the shores of these erstwhile fish abundant lakes. Deichsel deals with one such lake, Lake Baringo in the northern Kenyan Rift Valley. Also, Lake Baringo has served as a last resort for herders. Especially along its northern shores pastoral Pokot settled in case their herds had been depleted beyond a minimal subsistence level. The Njemps community has had a more continuous hold of the lake's resources and the Tugen, on which Deichsel's thesis focuses, came to the lake shores during British colonial times. The colonial administration broke the military superiority of pastoralist communities in the region and provided the Tugen community with guaranteed access to the lake. Since about 60 to 80 years Tugen fishermen have worked on and with the lake accumulating an invaluable set of indigenous knowledge. It is this knowledge that Deichsel's thesis focuses upon. Deichsel conducted fieldwork at Lake Baringo for about 2 months in 2013. She interviewed mainly males from the small Tugen fishermen community. While the larger part of her interviews were qualitative focusing on the history of human-environment relations at the lake, she also employed formalized questionnaires to elicit cognitive patterns. Deichsel is especially interested in how Tugen fishermen interpret certain hazards that endanger their livelihoods.

Abstract

Wetlands constitute some of the most important ecosystems in the world. They provide a number of critical ecosystem services that are indispensable to human beings and to the survival of biodiversities, health and welfare. Despite their importance, wetlands are being degraded and lost more rapidly than other ecosystems. In Kenya, where wetlands cover 3-4% of the country surface area, their rich physical and biological resources have led them to be overexploited and many of these ecosystems are seriously degraded. Wetland management decisions in Kenya are usually implemented by government departments and institutions with very little local community involvement. Based on the understanding that the integration of local knowledge is necessary to formulate adequate management strategies and that local involvement helps to enforce those, this study seeks to capture the value of local knowledge for wetland management approaches as well as for further research work. Specifically, this study focuses on local knowledge of Tugen fishermen on the environmental changes of the Ramsar Site of Lake Baringo in in mid-west Kenya.

Contents

List of acronyms

ASALs	Arid and Semi-Arid Lands
DEWA	Division of Early Warning and Assessment
FAO	Food and Agriculture Organization of the United Nations
IFRC	International Federation of Red Cross and Red Crescent Societies
IISD	International Institute for Sustainable Development
ILEC	International Lake Environment Committee
MEA	UN Millennium Environment Assessment
MEMR	Ministry of Environment and Mineral Resources (Kenya)
MoDP	Ministry of Devolution and Planning (Kenya)
NCPD	National Council for Population and Development (Kenya)
NDMA	National Drought Management Authority (Kenya)
NEMA	National Environmental Management Authority (Kenya)
UNEP	United Nation Environment Programme

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1 Introduction

Wetlands constitute some of the most important ecosystems in the world. They provide a number of critical “ecosystem services” (MEA 2005) that are indispensable to human beings and to the survival of biodiversities, health and welfare. These ecosystem services provided by or derived from wetlands are a) provisioning services such as food, fresh water, fibre and fuel, b) supporting services such as soil formation and nutrient cycling (which is “the storage, recycling, processing, acquisition of nutrients” (MEMR 2012, 70)), c) regulating services such as water regulation, erosion regulation and natural hazard regulation and d) cultural services like recreational and aesthetic values (MEMR 2012). Despite their importance for humankind and nature, wetlands including water catchment areas are being degraded and lost more rapidly than other ecosystems (ibid).

In Kenya, wetlands cover 3-4% of the country surface area. Their rich physical and biological resources have led them to be overexploited and many of these ecosystems are seriously degraded (MEMR 2012). Even though the Ramsar Convention's wise use of wetlands principle has been in force in Kenya since 1990, the absence of a national wetlands policy and a sector-specific wetlands law continue to hinder sustainable wetland management (ibid). The wise use of wetlands principle is defined as “maintenance of their ecological character, achieved through the implementation of ecosystem approach, within the context of sustainable development” (Ramsar Convention Secretariat 2006, 50). In Kenya, where the principle yet needs to be fully realised, major challenges facing wetlands include: over-extraction of water, fragmentation of land, deforestation of major water catchment areas, overgrazing, invasive species, over-exploitation of wetlands goods, such as fish and plants, and others (UNEP News Centre 2013).

With the need of improvement for wetland management at government level, the questions arise what role local stakeholder play regarding control over their immediate environment and how their experiences could impel management efforts. As described above, in Kenya major management decisions are usually implemented by government departments and institutions with very little local community involvement (Terer et al. 2004). However, lessons learnt during assessments in lake[1] areas have shown that “involvement of communities helps make the benefits of the rules clearer to those affected, draws upon the accepted authority of local leadership, uses their local knowledge for better design and enforcement, and reduces the cost to the central government”, as the International Lake Environment Committee noted (ILEC 2005, 43).

[1] Lakes are a type of wetland according to the Ramsar Convention which describes wetlands as “areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres” (Ramsar Convention Secretariat 2006). This definition does not encompass permanent, deep water bodies although it includes the shallow portions near the shorelines and riverbanks.

This study was designed based on the understanding described above, namely that the integration of local knowledge is necessary to formulate adequate rules and that local involvement helps to enforce those. Specifically the possibilities of local knowledge for the analysis of environmental changes in the fragile ecosystem of a wetland, were explored. Thereby Lake Baringo was chosen as study site: the Rift Valley lake is a Wetlands of International Importance (Ramsar Sites) which is, as a freshwater body, particularly important for local residents. The lake has repeatedly undergone environmental changes within the last century, which have greatly impacted lake communities (Aloo 2004; ILEC 2005; Johansson et al. 2002; Odada et al. 2006; Lwenya et al. 2010 and others). For this reason, this study aimed to analyse knowledge of fishermen from the local Tugen community on environmental changes of Lake Baringo. It was intended to tap this mostly underestimated source of knowledge using unstructured interviews and card piling processes to give a local perspective on which environmental challenges there are for the lake, its environment and for those relying on the lake as a resource for their livelihood.

1.1 Research objective and questions

Based on the situation described above, this case study was conducted with the following objectives and research questions in mind:

1) To explore local knowledge of Tugen fishermen on the ecosystem of Lake Baringo
   a) What changes have Tugen fisher been observing over time regarding the lake, fish stock, and the adjacent environment?
   b) How do they interpret those changes?

2) To analyse the fishermen's understanding of hazards to the lake environment;
   a) What are the hazards to the lake's ecosystem and
   b) How do fishermen evaluate them?

3) The fishermen's knowledge on the lake's ecosystem shall then be developed into a form of hybrid-knowledge using scientific data from other sources.
   a) What official data is there regarding the changing environment of Lake Baringo?
   b) In what way can Tugen local knowledge be incorporated in scientific research and therefore function as a complementing source of knowledge?

1.2 Composition of the thesis

The composition of this thesis consists of the following:

- Introducing the research question in chapter one;
- A portrayal of data collection and methods of analysis in chapter two;
- An explanation of key terms and concepts such as *local knowledge*, *hazard and hazard perception* and *environmental change* will be presented in chapter three;

- In chapter four the context of Lake Baringo, namely the lake as a Ramsar Site, the lake area's climatic characteristics as well as the socio-economic situation for local communities will be focused on;
- Presenting and scrutinising data gathered during fieldwork occurs in chapter five;
- The discussion which reflects on the main findings of the research follows in chapter six; and
- Conclusion will be the frame of chapters seven.

2 Data collection and analysis

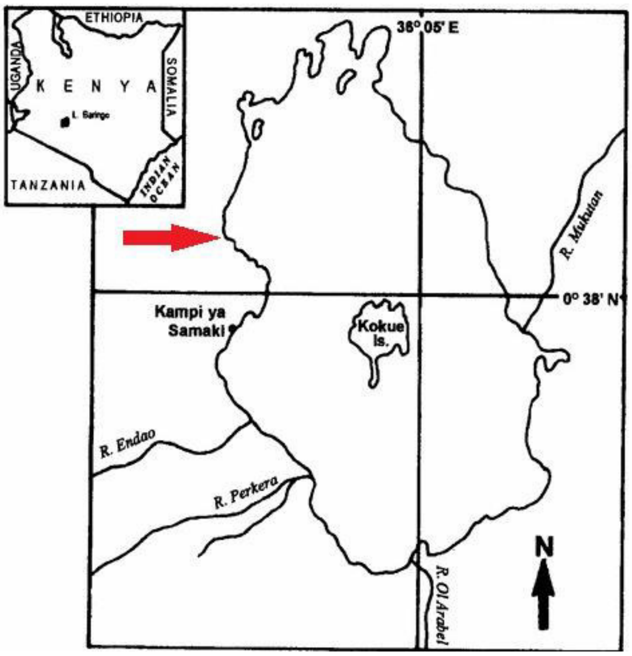
2.1 Methodology: choice of study area and informants

This study was carried out from March 15th to April 21st, 2013 at Ngenyin Beach of Lake Baringo in mid-west Kenya. Lake Baringo is one of the seven inland drainage lakes within the Kenyan section of the Rift Valley and it drains an area of over 6800 km^2. The lake lies at an altitude of 915m above sea level, latitude 0º44´and 0º 34 N and longitudes 36º 00´E and 36º 10´E. (Ngaira 2005)

The two main perennial rivers are Perkerra and Molo which, however, have significantly reduced water discharge during dry seasons. Further, several seasonal rivers drain the lake, including Ol Arabel, Makutan, Tangulbei, Endao and Chemeron. Lake Baringo is one of two Kenyan freshwater Rift Valley lakes (the other is Lake Nakuru); as a freshwater body in a semi-arid region, the lake is most-valuable as water resource for domestic and livestock consumption and it provides additional possibilities of income through fishing and tourism. In 2002 Lake Baringo gained recognition as a wetland of international importance, this in turn has led to more options being available to support livelihood opportunities there (Odada et al. 2006; Ramsar Convention Secretariat 2002).

Indigenous communities living in the basin area are the Pokot, the Njemps and the Tugen. The Pokot do their fishing in the northern part of the lake. In the eastern and southern part and on the islands are the Njemps. Tugen live and fish on the west shores, as Douglas Limo, employee of the Department of Fishery in Kampi ya Samaki explained (Interview with Douglas Limo on 14 April 2013).

Ngenyin Beach, the place of study, is a designated fish landing site; it is located on the west shore, approximately a 60 minutes hike or a 15 minutes bodaboda-ride (motorcycle-taxi) north of Kampi ya Samaki, the only major town by the lake (map 1). The beach is therefore quite remote and especially during wet season not easy to access because the paths to the beach turn muddy and become hardly passable. The environment of the landing site is hallmarked by volcanic ground and bushwood some of which is of the Prosopis juliflora species. All fishermen operating from Ngenyin Beach are members of the Tugen community. By their own account there were 30 fishermen and a community of 1000 people associated with the fishermen of Ngenyin Beach. Fish is a source of food and the sale of fish in Kampi ya Samaki generates income for the community. Within the Tugen community jobs are clearly allocated: men fish, women gut and clean the fish before selling them on the market in Kampi ya Samaki (for more detail see 5.1).



Map 1: Lake Baringo with study site
Source: Aloo 2004

2.2 Data collection

2.2.1 Unstructured interviews

When beginning this fieldwork, the intention was to slowly enter the field in order to get to know all informants and their living environment. This way the research could be guided by local knowledge: by pointing out topics related to environmental change of Lake Baringo, informants helped to focus and to structure this study. That is why unstructured interviews were chosen as the most suitable method for the first phase of this study.

> *Unstructured interviews are based on a clear plan that you keep constantly in mind, but are also characterized by a minimum of control over the people's responses. The idea is to get people to open up and let them express themselves in their own terms, and at their own pace. […] Unstructured interviewing is used in situations where you have lots and lots of time […]* (Bernard 2011, 157).

As Bernard points out, "lots and lots of time" is crucial when conducting unstructured interviews. Due to the time restraints of this study there was a need for follow-up questions in the process of interviewing. However, interviews did not follow a prepared list; questions asked mainly helped to clarify information previously given by the informant. All interviews were translated on the spot by a local translator, Elijah Limo (42), who himself is a member of that Tugen community and whose father is an active fisherman. Thus, interviews were carried out in Tugen, a Kalenjin dialect, immediately translated into English (and vice versa) and recorded for later transcription. The transcription of speech was carried out at a later point in time, however still in Kenya. During the interviews the information gained was thoroughly analysed back in Germany following the qualitative content analysis, a method created by Philip Mayring (see 2.3).

2.2.2 Card piling

The method of card piling is used when exploring cognitive relations between certain topics (Bernard 2011, 349). All relevant topics were taken from the previously conducted unstructured interviews after a first approximate analysis. Those topics were summarised under one term where possible, and written on cards (one card per term). Informants were asked to sort cards into piles according to which terms they thought belonged together. The idea behind this approach was to find out how topics mentioned during the interviews could be linked with one another. At a first trail, many difficulties were experienced due to (a) amount of cards, therefore terms presented, (b) language barrier (terms were given in English which most of the informants do not speak), and (c) illiteracy of informants.

After revising the process of card piling, the second attempt was more successful. First of all, only 10 instead of 23 terms were presented, however still in English. Secondly, the translator was asked to carry out the card piling under researcher's supervision. And thirdly, instead of exploring random cognitive relations between terms, this attempt focused on a ranking of experienced hazards to Lake Baringo. Ten fishermen were asked to sort the terms into three categories, namely “most hazardous”, “less hazardous”, and “least hazardous”. In a second step, they were asked to gradually rank the category “most hazardous”. Terms used for the card piling process were:

Table 1: Terms used for card piling process

1) Lungfish	6) Rainy season
2) Catfish	7) Human population around the lake
3) Crocodiles	8) Other fishermen
4) Rivers	9) Prosopis
5) Drought season	10) Chemicals

Source: author's data analysis (Deichsel fieldwork 2013)

2.3 Data analysis: qualitative content analysis after Philip Mayring

The qualitative content analysis was considered to be the best suitable method for answering most of the previously presented research questions, as the raw material mainly consists of transcribed speech. Content analysis is understood as a “method for the collection of social reality which uses characteristics of a manifest text to indicate the characteristics of a non-manifest context" [author's transl. from German] (Merten 1995 cf. Atteslander 2003, 224)

According to Philip Mayring, the main objective of a qualitative content analysis is to analyse (fixed) communication in a systematic manner. Thereby systematic manner stands for a rule-guided procedure, a procedure which is also guided by theory (Mayring 2008, 13). In order to apply a qualitative content analysis after Mayring, the first step is to determine a specific investigation period. For this work the entire period of fieldwork at Lake Baringo, Kenya, and therefore all interviews recorded during that time were considered relevant. The next step is what Mayring calls inductive category development. Mayring defines categories as "aspects of interpretation" which need to be "as near as possible to the material, to formulate them in terms of the material" (Mayring 2000, n.p.). At the core of any content analysis is what follows then, namely the deductive category application. "Deductive category application works with prior formulated, theoretical derived aspects of analysis, bringing them in connection with the text" (Mayring 2000, n.p.). The main idea here is to give explicit definitions, examples and coding rules for each deductive category, determining exactly under what circumstances a text passage can be coded with a category. The category and sub category definitions are put together within a coding agenda[2]. As Mayring (2000) suggests, all category definitions, text passages, and rules for distinguishing different categories for this work were completed step by step, and revised with the process of analysis. Resulting from this process are the following categories and sub categories which are also the basis for the structure of this paper.

[2] All completed coding agendas of this work can be found in the appendix section.

Table 2: Complete categories and sub categories resulting from content analysis

Category	**Sub category**
1. Description of the lake in the past and today	1.1 Fluctuating water levels 1.2 Fish stock 1.3 Climatic situation 1.4 Water quality
2. Description of fish stock in the past and today	2.1 Change in fish stock 2.2 Reasoning for change 2.3 Tilapia 2.4 Barbus 2.5 Labeo 2.6 Lungfish 2.7 Catfish 2.8 Breeding space
3. Hazards to the lake [=fishing business]	3.1 Human population 3.2 Other fishermen 3.3 Decrease of water level 3.4 Crocodiles 3.5 Drought 3.6 Dams 3.7 Water pollution 3.8 Lungfish 3.9 Siltation
4. Change of fishing practice	4.1 Single hooks 4.2 Fishing nets 4.3 Long lines with many hooks 4.4 Time as a business factor 4.5 Fishing routine 4.6 Fishing ban
5. Environment around the lake	5.1 Introduced species 5.2 Erosion 5.3 Livestock

Source: author's data analysis (Deichsel fieldwork 2013)

3 Literature review and concepts

In order to approach the subject of this research in all its complexity some key terms and concepts need to be discussed before data analysis and data presentation. As has been said earlier, this study concentrates in particular on local knowledge; it is therefore intended in this section to find out how local knowledge differs from other forms of knowledge, who possess it, and what possibilities local knowledge contains for environmental management strategies. Further the notion of hazard and hazard perception will be portrayed in order to discuss a linkage between hazards, hazard perception and society. And thirdly, the meaning of environmental change in connection to local knowledge and hazard will be a topic of this section.

3.1 Local knowledge

In the discourse regarding the interface between social and ecological systems, some scientists argue that western paradigms and systems of knowledge are currently not able to deal with the full complexity of environmental management (Raymond et al. 2010; Ludwig et al. 2001). It is argued that this is because local stakeholder perspectives are not sufficiently integrated in the development of such management strategies. In order to manage environmental problems, meaning their scope, complexity and uncertainty, it is therefore been requested to take account of different types and sources of knowledge. Resulting from this argumentation, the current challenge for researchers is "to develop 'user-inspired' and 'user-useful' management approaches" for which local knowledge needs be considered "alongside scientific knowledge" (Raymond et al. 2010, 1766).

Since western paradigms and systems of knowledge are no longer seen as "enough" (Ludwig et al. 2001, 482), it has been argued that "somehow that knowledge must be integrated with political, economic, social, ethical and religious insight and tempered with respect for human dignity and for the biosphere" (ibid). The biggest challenge for combining different types of knowledge is, however, that there are various perspectives of what constitutes knowledge and of how someone comes to know something. To reach clarity in this matter there have been attempts to develop knowledge categories. With the result that more than one possible way of knowledge categorisation has since been developed, this leads to confusion about the meaning of a category. As a direction-giving overview, Raymond et al. present a simplified version of knowledge categories expressed under three broad headings:

- localised, experimental or indigenous knowledge;
- more formalised 'scientific' knowledge;
- 'hybrid' knowledge (2010, 1767).

The authors summarise the first broad category as 'local knowledge', which they define as “the informal, lay, personal, often implicit or tacit, but possibly expert knowledge” (Raymond et al. 2010, 1768). The second category, 'scientific' knowledge, is specified as “the often explicit knowledge that has been derived from applying more formal methods that aim to increase rigour in relation to different perceptions on validity and reliability” (ibid, 1768f.). And thirdly, 'hybrid' knowledge is described as “the new understandings which emerge through the integration of different types of knowledge (such as local and scientific) and/or through multi-, inter-, or trans-disciplinary research” (ibid, 1769). Looking at the explicit use of inverted commas when classifying categories of knowledge, it can be reasoned these category terms are not to be understood as absolute terminology and that categories can overlap. For example, scientific findings as accurate as they may be, are always interpreted by individuals who make sense of them in relation to what they know and to what they have experienced in their own past. “This implies that knowledge is inherently personal with different people interpreting the same information in different ways” (ibid, 1769).

In her work on local knowledge in the environment-development discourse, Anja Nygren states that in order to emphasise a difference between expert knowledge and local knowledge a discourse has long been utilised which featured sharp contrasts like “rational/magical, universal/particular, theoretical/practical and modern/traditional” (Nygren 1999, 271). Thereby the capacity of local people to innovate, systematise and transfer knowledge was portrayed as limited in contrast to scientific knowledge which was considered “rigorous and cumulative” (ibid, 273).

Nygren further argues that in addition to the interpretation of knowledge, the production of all knowledge is also much influenced by personal perspectives and ideologies. Personal perspectives are in turn shaped by contextual factors and the values of the society in which a person is embedded:

> *There was little recognition of the fact that in practice science is ‘achieved’ in much the same way as other forms of knowledge – through social construction and negotiation* (ibid).

For this study the term *local knowledge* is used in reference to knowledge obtained mainly through living in a certain environment, through dealing with changes and challenges within this environment and through observing them. As Antweiler states:

> *[Local knowledge] is neither indigenous wisdom nor simply a form of science, but a locally situated form of knowledge and performance found in all changing social and natural environments* (2004, 1).

Local knowledge can thus also stand for skills and capabilities as they are acquired and applied by people with respect to their local objectives, situations and problems: local communities know of materials and energy sources available to them on site which can be consulted for problem solving and other practices. In reference to Antweiler, *local* in this context is not to be understood as exclusively referring to a location, but rather as knowledge being culturally and ecologically situated (2004, 2).

Because local knowledge can be regarded as culturally and ecologically situated, it is assumed that not necessarily all members of a community share a comprehensive knowledge system. Different statuses and allocation of tasks within a community (due to age, gender etc.) impact areas and transfer of knowledge (Bicker et al. 2004, xi). Further, local knowledge informed activities are not necessarily sustainable, or socially just. "Such knowledge is not only cognitive, but entails emotive and corporeal aspects" (Antweiler 2004, 10).

A decision model "for the incorporation of indigenous knowledge into development projects" by Sillitoe & Barr shows how agencies can effectively make connections between local people's understanding and practices, and research and development approaches. The model proposes:

- *facilitating meaningful communication with local people;*
- *understanding and valuing local people's knowledge and practices;*
- *identifying research or development initiatives to address jointly perceived problems;*
- *advancing participatory research to identify and tackle constraints more effectively; and*
- *discussing with people the social, environmental and other consequences of any action* (Sillitoe et al. 2004, 59).

What might sound rather obvious at first, however, seems necessary to point out when considering the apparent lack of incorporated local knowledge, especially in wetland management. Thereby the model assumes that by paying attention to local perceptions and practices, research and development initiatives are more likely to meet people's needs as well as they are more likely to create acceptance for change among the local population.

3.2 Hazards and hazard perception

The term *hazard* plays an important role in various disciplines from technical sciences to social sciences, as well as in various professional contexts. Consequently, there are many definitions for the term (Paul 2011, 2).

Concepts given in literature often distinguish between *natural hazards* and *technological* i.e. *man-made hazards*. The International Federation of Red Cross and Red Crescent Societies (IFRC), for example, define hazards for their work in disaster management as follows:

> *Natural hazards are naturally occurring physical phenomena caused either by rapid or slow onset events which can be geophysical (earthquakes, landslides, tsunamis and volcanic activity), hydrological (avalanches and floods), climatological (extreme temperatures, drought and wildfires), meteorological (cyclones and storms/wave surges) or biological (disease epidemics and insect/animal plagues).*
>
> *Technological or man-made hazards (complex emergencies/conflicts, famine, displaced populations, industrial accidents and transport accidents) are events that are caused by humans and occur in or close to human settlements. This can include environmental degradation, pollution and accidents, technological or man-made hazards (complex emergencies/conflicts, famine, displaced populations, industrial accidents and transport accidents)* (IFRC 2011).

Here, natural hazards and man-made hazards are initially viewed as two separate phenomena. For instance, droughts and floods are allocated to the category of natural hazards whereas environmental degradation is categorised as man-made hazard. Thus, it is a definition which does not immediately point out the role of humans in causing or amplifying the impacts associated with hazards. As a counter-argument for this approach, it can be said that floods, to give one example, can originate either from a natural change in meteorological conditions, or from human action, such as deforestation, intensive use of land or failure in dam construction (Paul 2011, 3). Natural and technological hazards should hence not be seen as completely disjointed.

A rather new development in the classification of hazard and disaster recognises a linkage between hazards and a society, which Paul describes as a "major shift" (Paul 2011, 21). Only a decade ago, he claims, it was common practice to neatly divide between events caused by nature and those caused by humans. As seen earlier, the IRFC continues to hold on to this disposition, whereas in more recent research, hazards and disasters are viewed as "continuum of physical/environmental, social and technological systems" ranging from "extreme natural events to technological failure to social disruption to terrorism" (Paul 2011, 21).

There is therefore little doubt that humans affect natural processes and often contribute to hazards. But hazards are more than the actual disastrous event with all its consequences. They also mean the probability of occurrence of a potentially damaging phenomenon – hazards have "the potential to harm individuals or human systems" (Pelling 2003, 5). Or as Smith puts it, they are "naturally occurring or human-induced process(es) or event(s) with the potential to create loss, i.e. a general resource of danger" (Smith 1996, 5). In both definitions, again the aspect of potential loss and harm to individuals or a whole society is key. This leads to the question of perception of hazards.

As discussed above, looming threats can be as much of a hazard as the actual event. As a consequence, everyday hazards or chronic disasters are felt as long-term stresses.

Examples of everyday hazards are poor sanitation, unfit housing and polluted air among others (Pelling 2003, 15). Apart from the living conditions, there are numerous factors that influence perception:

- Individual characteristics. Wealth, household status and gender can influence the risk of hazard exposure. These individual characteristics can also influence a person's ability to mitigate an imminent loss or cope with its aftermath;
- Cultural and community characteristics. For example the existence or absence of strong social safety nets or conflict resolution mechanisms;
- Culturally determined gender roles. Differentiated roles between men and women play a guiding factor on how an individual perceives and responds to looming danger. (Nduru et al. 2012, 137)

Hazards associated with climate variability are plentiful and multifaceted. That is why "indigenous perceptions of sustainable resource management and of environmental degradation give a good idea of emic accounts of environmental vulnerability" (Bollig 2006, 12). In their work on climate variability risks, perceptions and coping mechanisms in Kenya, Nduru and Kiragu support this claim in stating that understanding perceptions about those climate related hazards are "crucial in determining virtually everything that rural people especially in arid and semi-arid areas do" (Nduru et al. 2012, 138).

As mentioned earlier, culture and community characteristics strongly influence a person's hazard perception. This is also true for the willingness to participate in innovations initiated and introduced from outside. Until local people gain respect for an initiative, they will not adopt it as a coping mechanism, or as a form of mitigation against a looming risk. As the International Lake Environment Committee (ILEC) state "people are more easily convinced by their neighbours' experiences and tend to trust those they live with rather than outsiders" (ILEC 2005, 49).

3.3 Environmental change

When searching for definitions of environmental change, most information available is directly linked to climate change and global warming. It should be pointed out, however, that climate change is only a part of environmental change as a whole, which covers change in the lithosphere, landscape (geomorphology), hydrological systems (including the oceans and ice), vegetation and fauna, as well as climate change (Wainwright 2011, 14).

Much of the debates on global environmental change have been based around the activities of the Intergovernmental Panel of Climate Change (IPCC). The IPCC is a joint initiative of the World Meteorological Organization (WMO) and the United Nation Environment Programme (UNEP) which has so far published four assessment reports since its establishment in 1988. Corresponding Slaymaker et al summarise the conclusions of the latest report on climate change (published 2007) as follows:

- warming of the climate system is apparent;
- palaeoclimate information supports the interpretation that the warmth of the last half century is unusual in at least the previous 1300 years;
- most of the observed increase in globally averaged temperature since the mid twentieth century is very likely due to the observed increase in anthropogenic greenhouse gas concentration […] (Slaymaker et al. 2009, 1)

But what does *change* actually mean? By dictionary definition, change is "an act or process through which something becomes different; substitution of one thing for another; an alteration or modification" (Oxford English Dictionary 2013b) It becomes clear that the character of any change may take on a number of forms. In the context of environments, for example, climate variations may be periodic (hence predictable), quasi-periodic (only predictable in a broader sense) or non-periodic. (Bradley 1999, 11ff.) Changes may also occur in a number of less obvious ways. "For example, the frequency of an oscillation may vary, or the magnitude of the variability around the mean may increase or decrease" (Wainwright 2011, 15).

The spatial scale of our observations about our environment also affects the way in which we perceive changes in the global environment. Research strategies can commonly be allocated to either *top-down* or *bottom-up* approaches. Top-down approaches generally require conceptual interpretations of global systems. Bottom-up approaches involve an integration of local data from a large number of settings. "Only by the convergence of the interpretations possible from these two approaches can we be confident that our understanding is reasonable" (Wainwright 2011, 15).

On a local level, our perceptions of change are generally guided by experiences. "We feel comfortable with the daily, seasonal and to a certain extent interannual changes, because those are the ones of which we have direct experience and memory" (Wainwright 2011, 14). Changes on a decadal scale are less obvious, but still kept in a collective memory. Beyond the length of a single lifetime, however, it is argued that we find it increasingly difficult to perceive changes because they rely on the assimilation of information that is much more indirect (ibid). When analysing human aspects of environment change, it is important to consider the differences between direct and indirect impacts. "Often, the most important effects are those where human activities have caused feedbacks in other parts of the environmental system" (ibid).

4 Context of Lake Baringo

4.1 Climatic situation and environment

Lake Baringo is located in a semi-arid zone which has all characteristic features of arid and semi-arid lands (ASALs). These are low erratic rainfall, periodic droughts and different associations of vegetative cover and soils (IISD 2010). The lake experiences very high annual evaporation rates, compared to an annual rainfall of 450-900 mm. Being in the Intertropical Convergence Zone (ITCZ) the lake has two rainy seasons with long rains in the months of April to August, whereas the short rains fall from October to November (Hickley et al. 2004; Odada et al. 2006). Variation in rainfall occurs on a range of time scales, including El Nino and La Nina periods, i.e. every 5–7 years (Ogola et al. 2011).

With its islands, the swamps, the surrounding bushland, semi-desert strip vegetated with Acacia and the west cliffs of the Laikipia plateau, Lake Baringo is considered a globally unique paradise for ornithologists. Here over 500 species of birds have been observed. In addition, crocodiles and hippos can be found in the lake. (Hosang 2007) The streams flowing into Lake Baringo originate from humid and sub humid hill slopes, where the annual rainfall is over 1000 mm. As will be discussed later (see 5.2), these streams are the major source of recharge for the lake. Due to deforestation in the water recharge areas, groundwater recharge has decreased, with streams drying up more often during the dry seasons, whereas they cause flash floods during the rainy seasons. As a result of the floods, loss of property and displacement of people have been prevalent in the lower reaches of the basin. (Odada et al. 2006) Another risk to the lake is siltation due to soil erosion (see 5.2). The soils are clay and clay loams and the risk of soil erosion is high because of the soil properties: "clay fills pores or seals the surface giving low infiltration capacity" (Hickley et al. 2004).

According to the Kenyan Ministry of Devolution and Planning (MoDP), the primary policy challenge in the Baringo area is how to ensure food and nutrition security in a sustainable manner. Since the environments in ASALs are prone to drought, access to and control over critical livelihood resources such as land is insecure, and climatic change will increase this unpredictability (MoDP 2011).

4.2 Lake Baringo as a Ramsar Site

In 2002 Lake Baringo was declared a Ramsar Site, which gave official recognition to the lake as a "Wetland of International Importance" (Ramsar Convention Secretariat 2002). The Convention on Wetlands (Ramsar, Iran, 1971) is an intergovernmental, non-UN-related treaty whose mission is "the conservation and wise use of all wetlands through local, regional and national actions and international cooperation, as a contribution towards achieving sustainable development throughout the world" (Ramsar Convention Secretariat

2006). Specifically the treaty encourages member countries to stop the progressive intrusion and loss of wetlands by recognising the fundamental ecological functions of wetlands as well as their economic, cultural, scientific, and recreational value.

Wetlands play a significant role in the livelihoods of rural communities (Wellington et al. 2010; Frenken et al. 2002). They store water during the wet season and release it during the dry season. Therefore wetlands support human welfare such as livestock grazing and watering, water supply, crop production and for this paper the most important aspect, fishing (Gichuki et al. 2006). Furthermore, wetlands are important for tourism due to their unique landscape and rich biodiversity. For Lake Baringo, it has been remarked that "local fisheries are particularly important for sustainable development of the local communities, for both economic and sport fishing" (Ramsar Convention Secretariat 2012).

As has been highlighted, Lake Baringo as a Ramsar Site has a great value and needs corresponding management. According to the National Environmental Management Authority (NEMA) adopting and implementing Ramsar convention guidelines has assisted in the conservation of some wetlands, yet many of Kenya's wetlands continue to experience pressures and threats from both natural events and human activities. NEMA also detected that Kenya does not have a comprehensive wetland policy. As a result, wetland management issues continue to be undertaken in a disjointed manner (NEMA 2012).

Looking at the management difficulties on the political level one might wonder about the role of local people organising their immediate environment and sustain their livelihoods. A study on socio-economic values and traditional strategies of managing wetland resources in Lower Tana River, Kenya, has shown again that major management decisions in Kenya are usually implemented by government departments and institutions – with very little local community participation or involvement (Terer et al. 2004). As a result local expertise will seldom find recognition in management plans of such sites.

Wetland systems are vulnerable and particularly susceptible to changes in quantity and quality of water supply. Reducing pollution, controlling introduced vegetation, and protecting wetland biological diversity are important examples of how to maintain and improve the resiliency of wetland ecosystems (Erwin 2009). For such endeavours, incorporating local knowledge could help greatly in order to identify stress factors.

4.3 Means of income in the Baringo area

As already mentioned, the study area is characterised by ecological stresses which result in economic challenges for the population. Concretely, recurrent droughts, inadequate freshwater and firewood, inadequate infrastructure, poor market access, insecurity, poverty and high vulnerability to diseases are very prominent and cause demanding living conditions (Ogola et al. 2011, 4225). According to the Kenyan National Council for Population and Development (NCPD), poverty in Baringo District is estimated to affect 35%

of the total population (NCPD 2005, 7). However, the World Bank states in their 2008 assessment on poverty and inequality in Kenya that even 40-50% of the district's population live below the poverty line of USD 1.25 per day (World Bank 2008, 26). Within the district, poverty is more pronounced in the rural areas especially in the lower zones. Non-diversified income-earning activities have been mentioned as a cause creating this situation (NCPD 2005, 7). The main economic activities in the region are nomadic pastoralism, agro-pastoralism, bee keeping, fishing, local aloe production, irrigated and rain fed agriculture, and tourism (Ogola et al. 2011, 4225). Three of these income activities related to the scope of this study shall now be viewed.

4.3.1 Fishing

Fishing has functioned as an important survival strategy for struggling agrarian and pastoral communities. But it is also known as a seasonal activity for those (agro-) pastoralists more temporarily involved in herding or cultivation elsewhere. According to Anderson and Broch-Due this flexibility is due to the fact that the equipment needed to set up fishing is rather simple (1999, 60). The authors continue arguing that African lakes therefore contribute significantly to poverty reduction and food security. “They are a source of dietary proteins and water, they provide revenue through fish harvest, export and tourism, and are used as transportation avenues. They also provide water for irrigation, agriculture and hydro-power projects” (El-Khanater et al. 2010, 3). During this century, though, African lakes have experienced declines in fish catches, reductions in fish species diversity, and deterioration in water quality which is especially true for Lake Baringo. As major challenges to fishery resources in Africa, Ogutu-Ohwayo and Baliwra list the following:

> *(i) large lake basin populations; (ii) unsustainable fishing practice; (iii) species introductions; (iv) loss of aquatic biodiversity; (v) pollution and eutrophication; (vi) invasive weeds; (vii) inadequate policy and legal regimes; (viii) inadequate institutions, institutional mechanisms and governance, including stakeholder commitment and participation; and (ix) inadequate and unsustainable funding mechanisms* (2006, 219)

When characterising the main challenges for fishery resources in Lake Baringo, Odada et al. agree with most points listed above. Especially the growing population in Kampi ya Samaki was pointed out as contributing to fluctuations in fish stock of Lake Baringo. Because of increasing fishing activities within the last 40 years, the village has transformed into a centre for trade; and this over-dependency on fish as a resource has caused severe decline in fish population. (Odada et al. 2005)

In order to improve fish stocks, a voluntary moratorium on fishing was implemented in 2001. The lake was alarmingly low that year and the fish stock was dwindling, thus the fishers experienced losses in income. By accepting the moratorium, the fishers of Lake Baringo gave a “powerful example of stakeholder involvement in enforcing rules” (ILEC 2005, 43).

After two years, the size of Tilapia has increased by 100 percent, which has, according to ILEC, strengthened local support for the fishing rules (ibid).

4.3.2 Agriculture

According to the Kenyan National Coordination Agency for Population and Development (NCAPD), most of the labour force in the Baringo District is unskilled and semi-skilled. The income of the district is therefore mainly derived from sales of livestock and agricultural products. Agriculture is thus important for poverty reduction and food security in the area. (NCAPD 2005) Throughout the world, agriculture is a commonly associated feature of wetlands. Conversely, many wetlands are threatened by agricultural practices, which, for instance, modify the hydrological regimes on which wetlands depend, and hence, the ecological character of wetlands and other benefits they provide, are being altered (McCartney et al. 2010).

For Lake Baringo the ILEC observed that the shrinking of the lake is (at least partly) happening because of excessive water withdrawal for upstream irrigation (ILEC 2005, 23). As mentioned earlier, the wise use of wetland principle, established by the Ramsar Convention, has not been fully put into practice in Kenya. The essence of the principle is the maintenance of a wetland's ecological character within the context of a sustainable development (Ramsar Convention Secretariat 2006). However, the realisation of this objective would not end the misery of the wetland agriculture as Wellington et al. state since there is an ongoing debate between conservation and development approaches:

> *A pure conservation strategy that aims at protecting the wetland leads to substantial reductions in economic welfare of the local population unless their livelihood sources are diversified into alternative non-farm employment and income options […] Therefore, improving the capacity of rural farmers to adapt to climate change, especially drought is important to reduce pressure on wetland resources (Wellington et al. 2010, 1577)*

Lake Baringo with its low water level is particularly vulnerable to changes in quantity and quality of water supply. In order to reduce the pressure on the lakes it would be necessary to lessen water withdrawal from the streams that drain the lake. This is not a sufficient solution by itself, when one also considers economic welfare of the local smallholders and the socio-economic situation of the area.

4.3.3 Tourism

The lake is an important tourist attraction because of its rich biodiversity, which comprises a unique variety of birds, as well as hippos and crocodiles. According to Little, the development of Baringo's tourist industry since the 1970s, has provoked interest in conservation programmes: “[b]ecause the maintenance of the resource base is critical to sustain the region's wildlife […], there is an incentive to improve local land use" (Little 1992, 172). Through tourism activities, the area has further been opened to other regions, both nationally and internationally. This has promoted business enterprises. Burnett and Rowntree list two types of tourists from outside of Kenya, namely the "pre-packaged safari travellers" and the "serious birder" (Burnett et al. 1990, 168). A third group mentioned, not directly declared as tourists, yet who are also of economic importance to the area, are scientists. Scientists often employ locals for menial work and both tourists and scientists are known to make demands on shop owners as well as on leisure facilities. Consequently, the supply has adapted to the demand as local tour guides offer tours on the lake and on land for "tourist prices". Especially during closed fishing seasons, local fishermen use tourist tours on the lake as an additional source of income. The Tugen fishing boats, as seen during fieldwork however, are not suitable for transporting passengers as they can only fit one person (see 5.1).

5 Data presentation

For a clear understanding, two formats of visualisation have been created for data presentation; Figures 1a/2a translate card piling results into bar graphs which give information about percentaged distribution of votes. In Figures 1b/2b the same results have been taken to develop a so called *word cloud* or visually weighted list which enables an easy access to data material.

Outcomes from qualitative content analysis are presented through periphrases and direct quotes in each section.

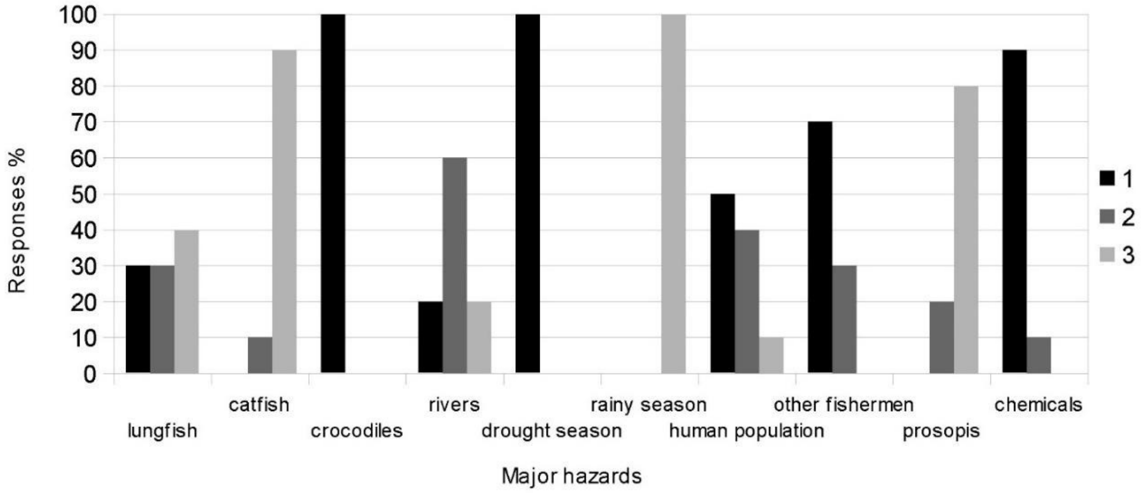


Figure 1a. Ranks of major hazards to Lake Baringo (n=10)
Ranks present (1) most hazardous, (2) less hazardous, and (3) least hazardous.
Source: author's data analysis (Deichsel fieldwork 2013)

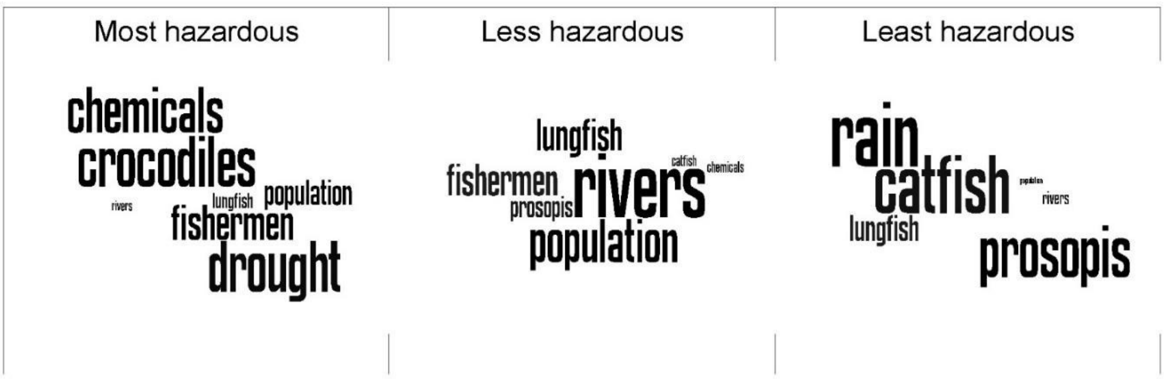


Figure 1b. Visually weighted list of major hazards to Lake Baringo (n=10)
Source: author's data analysis (Deichsel fieldwork 2013)

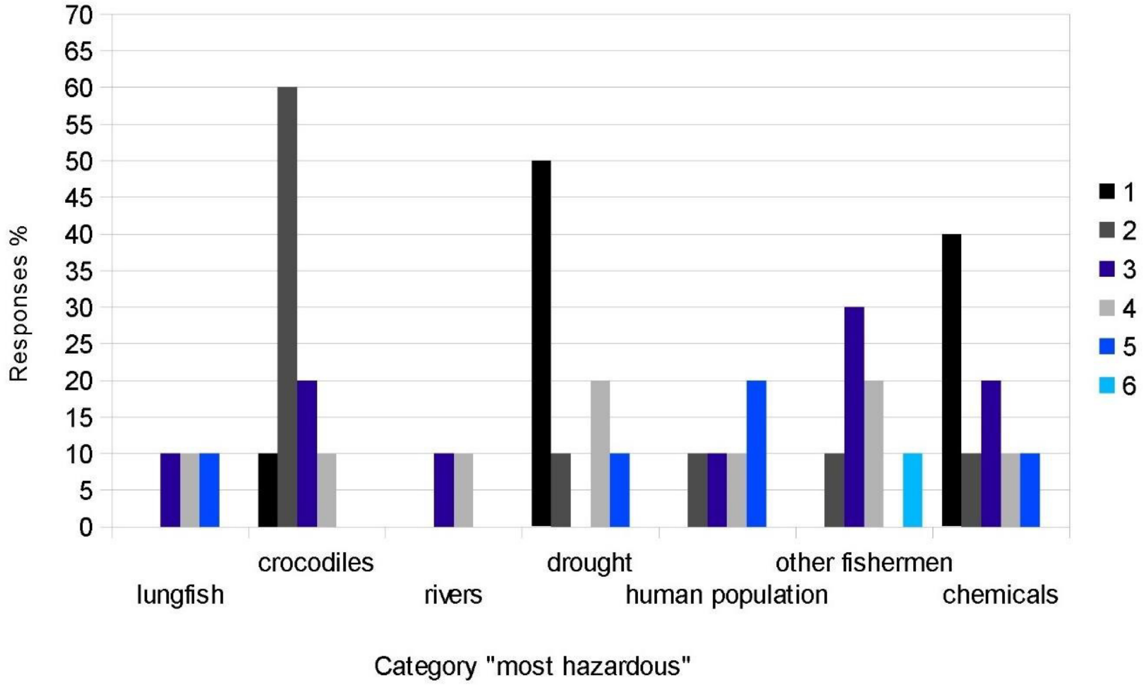


Figure 2a. Gradual ranks of the category "most hazardous" (n=10)
Ranks present (1) most hazardous, (2) 2nd-most hazardous, (3) 3rd-most hazardous, (4) 4th-, (5), 5th -, (6) 6th-most hazardous.
Source: author's data analysis (Deichsel fieldwork 2013)

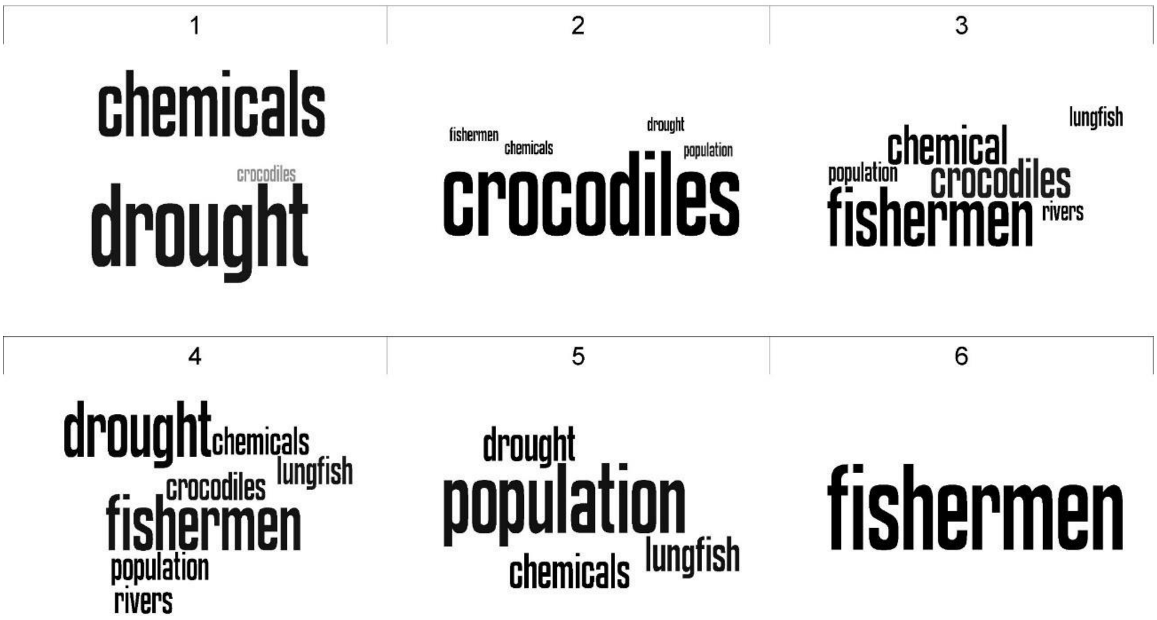


Figure 2b. Visually weighted list of category "most hazardous" (n=10)
Source: author's data analysis (Deichsel fieldwork 2013)

5.1 Tugen fishing practice today and in the past

In their work "Management challenges of freshwater fisheries in Africa" Richard Ogutu-Ohwayo and John Balirwa point out that fishing efforts on most of African lakes were originally low due of the small number of fishermen, poor fishing crafts, inefficient gear, and limited markets. However, the fishing business "on virtually all the lakes" (Ogutu-Ohwayo et al. 2006, 219) have since increased, because of "growing human population, improvement of fishing crafts, introduction of more efficient fishing gear and methods, and expansion of markets with improved communication" (ibid). This section will show that the authors' statement is also true for Tugen fishery at Lake Baringo. Yet, another complex topic needs to be addressed before evaluating the development of Tugen fishing practice, namely how the Tugen came to pursue fishery in the first place.

Excursus: Tugen in the Baringo area

The Tugen were, and partly still are agro-pastoralists who inhabited the high lands of the Rift Valley (Tugen Hills) until resettlement strategies under British colonial rulers moved them to the lowlands near the lake (Little 1992, 7). According to anthropologist Peter Little, two larger regional systems operated in the area in pre-colonial times, which enclosed many of the East Africa's important pastoral and agricultural groups. The first was the central Rift Valley system which included the Maa-speakers (Purko Maasai, Il Chamus etc.) as well as Kalenjin groups (Tugen and Nandi) and Bantu groups (Kikuyu and Kamba). The second region was the Lake Turkana basin, which included the Turkana, Dassenetch, Samburu, Boran and other predominantly pastoral groups. The two systems were integrated through networks of exchange. The advent of colonialism, however, drastically altered these regional relationships as these large regional systems were fragmented by administrative boundaries. The Colonial management established an administrative area around Lake Baringo (similar to today's Baringo District) composed of the Tugen, the Pokot and the Njemps. In Baringo each of the major ethnic groups occupied new lands in the 20th century because of military and resettlement policies by the colonial rulers. The Tugen, as already noted, were moved from the hills into lowlands grazing areas which had been used by Maa-speaking groups throughout the 19th century. (ibid, 17ff)

Unfortunately, no reference could be found stating exactly when the Tugen took up fishing, however it seems plausible that the relocation to an area near Lake Baringo influenced the process.

Tugen fishing practice today and in the past, continued:

The fishermen of Ngenyin Beach start their work routine every morning at around 7 a.m. It takes about half an hour to walk from their village to the landing site where all fishing boats are kept on the lake shores over night to dry. The material used for boat construction is balsa wood, a very lightweight and soft material. The lumber has a low density but is very strong. The name *balsa* comes from the Spanish word for *raft.* (FAO 1993; Oxford English Dictionary 2013a)

Once they have reached the beach, the fishermen's first action is to assemble the boats that consist of two separate parts. The main part has a semi concave shape with a pointed bow and an open stern. The second part looks like a thick straw mat and is made of interconnected balsa tree branches. When the two parts are joined together, a piece of plastic is put on top of the mat-like boat part, to prevent ingress of moisture. Two additional lumbers function as a thwart. To manoeuvre the boat, the fishermen use a piece of robust plastic in each hand. When I asked the question whether a fisherman uses the same boat every day or if boats are swapped, the response was given with amusement and laughter: "everybody has his own boat, no swapping!" It takes the fishermen usually half an hour to assemble their boat, so at around 8 a.m. each fisher paddles onto the lake headed to where he currently keeps his fishing net.

Image 1: Tugen fishing boat made from balsa wood
Source: Deichsel fieldwork March 2013[3]

The location for a fishing net is retained until a fisher decides that a new location will increase his fishing outcome. The fishing nets the Tugen use today are a type of driftnet; driftnets hang in the water vertically without being anchored to the bottom. The nets are kept vertically in the water by floats attached to a rope along the top of the net and by weights attached to another rope along the bottom of the net (Caddell 2010, 1). With these nets the Tugen aim to catch surface feeding fish like Barbus, and Tilapia. Carnivore fish, like catfish and lungfish, are caught by using a long line with attached baited hooks which is let deeper into the water.

[3] All the photographs presented in this study were taken by the author, i.e. Deichsel 2013

As soon as a fisher reaches his net, he checks the amount of fish caught; then he baits the hooks for the next day. A routine carried out at each net, every day. However, the fishing practice described above is a modern way of fishing, as Samuel Kimayo (66) explained:

> *The fishing practice has changed. In the early days, when I was young, we used to fish using lines with single hooks. The younger generations have fishing nets now. You can leave the net in the water the whole day and collect the fish then in the morning. Also we have now long lines with many hooks to catch big fish* (Interview with Samuel Kimayo on 23 March 2013).

Kimayo favours these new methods; they are less time consuming and more profitable even though their type of boat has not changed.

> *So, compared to the past, with one hook you spend the whole day on the lake and you only catch a few fish. The practice we do these days consumes less time and gives us better results. However, we still use the same style boats made from balsa wood* (ibid).

Summarised, lines with one hook have been replaced with line fishing and driftnets which make the fishing practice more convenient and profitable. The fishermen of Ngenyin Beach welcome the progress and value it as an improvement.

In the afternoon, around 1 p.m. the fishermen individually return to the landing site where the Tugen women are already awaiting them. The women's job within the community is to clean and gut the fish and carry them to the market for sale. By the lake the women threat and bundle smaller fish so they become easier to carry. Lager fish are being portioned. In Kampi ya Samaki women of different communities (mainly Njemps and Tugens) gather on the market place where they deep fry, dry and smoke their fish for customers.

5.2 Fluctuating water levels

In preparation for my fieldwork I consulted several studies about Lake Baringo and its environment. One prominent topic presented in the papers was the alarmingly decreasing water level of the lake and the consequences the decrease had already brought to the whole ecosystem since the beginning of the last century (Aloo 2004; ILEC 2005; Johansson et al. 2002; Odada et al. 2006; Lwenya et al. 2010 and others). With that information in mind I arrived at the lake only to find out that the water had reached a 50 year peak level. Regardless of whether very high or low water levels, it became apparent to me on site that the fluctuating water levels are an essential topic when discussing Lake Baringo.

Those fluctuations radically affect every part of the ecosystem, including humans who are an “integral part”, as the UN defines in their Millennium Ecosystem Assessment:

An ecosystem is a dynamic complex of plant, animal, and microorganism communities and the non-living environment interacting as a functional unit. Humans are an integral part of ecosystems […] (MEA 2003, 3).

Consequently, human activities within the catchment basin and their possible impacts on the lake conditions need to be addressed in more detail.

Records summarised by Odada, Onyando and Obudho indicate that between 1969 and 1972, the average depth of the lake was 8 meters. In early 2003, before the onset of long rains, the average depth reduced to only 1.7 m, and in 2005 the average depth rose to no more than 2.5 m (Odada et al. 2005). Alongside the water depth, the lake's surface area also underwent very apparent changes. In their work Odada et al. relegate to a previous study of Japheth Onyando who revealed that the surface area of Lake Baringo has steadily been decreasing for more than 25 years. "In 1976 it was 219 km^2, in 1986 it was 136 km^2, in 1995 it was 114 km^2, and in 2001 it was 108 km^2" (Onyando 2002 cf. Odada et al. 2005, 32). Based on this data, Onyando extrapolated that Lake Baringo is prone to vanish by 2050 (see Figure 3). Figure 3 also indicates that for the year 2013 Onyando predicted a surface area of less than 80 km^2, which however did not coincide with the situation I witnessed during my time there.

The interviews with the Tugen fishermen revealed more in-depth information on the fluctuating water levels of their lake. Since an ecosystem can be understood as a "dynamic complex [...] interacting as a functional unit", it becomes even more clear that, for instance, water levels and fish stock are interconnected. As a result, water levels have a great impact on the Tugen community who base their livelihood on fish consumption and trade. Water levels are therefore deep-rooted in the collective memory of the fishermen. Everyone questioned could connect water levels with concrete year dates.

Samuel Kimanyo (66) who was the most experienced fisher interviewed, shared his memories of the lake from when he was eleven years old:

I know the lake since I was a young boy, I can date it back to 1958. Then the lake fluctuated with seasons. Most of the time the lake was very low, lower than it is today […]. So, the water level increased from 1961 until 1965. From 1965 onwards the level went gradually down, not increasing at all, just went down – until the year 2000. In the year 2000 the lake was almost completely dry – a repeat from 50 years ago. The level remained that low until 2006. In 2006 the water was a little bit higher. The lake then gradually increased with the rains that kept coming. Until the year 2012 when the lake exploded again to the same level of 1961 ((Interview with Samuel Kimayo on 23 March 2013) 2013).

Thus, Kimanyo explained that because the rainy seasons were more frequent in the late 1950s, water level fluctuations were more predictable then than they are today. Yet, the lake remained shallow until 1961. Other important years Kimanyo mentioned were 2000, when the lake was “almost completely dry”, 2006, when “the rains kept coming”, and 2012, when “the lake exploded to the same level of 1961”. For visualisation Kimanyo's description was translated into the blue graph of figure 3. Dots represent exact year dates given in the interview, the connecting lines represent approximate trends resulting from wording during the interview. In another interview with Joseph Chesire, the fisherman mentioned two year dates in connection with lake levels. The latter are represented through the red graph in figure 3.

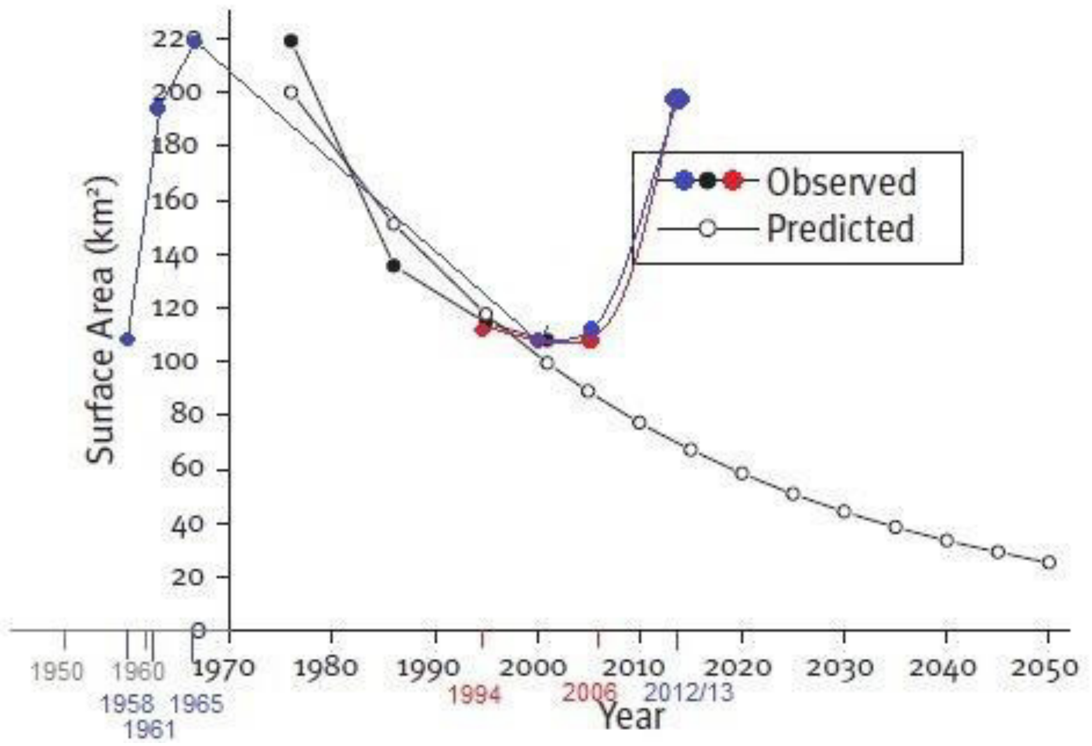


Figure 3. Observed and predicted surface area of Lake Baringo
Graphs “observed” present (blue) Kimayo 2013, (red) Chesire 2013, (black) Odada et al. 2005.
Source: Odada et al. 2005 & author’s rendering (Deichsel fieldwork 2013)

Looking at all four graphs in figure 3, it can be said that the fishermen's observations of the last 55 years express periodic trends. As Kimayo mentioned in his interview, the currently high water levels are a repeat of the situation from 50 years ago; as were the very low levels of 2000. In contrast to the fishermen's information, Onyando's extrapolation was based on data dating back just 30 years – which lead to a differing evaluation of and prediction for the lake's development. The fishermen did not give any predictions of how the lake levels might change in the future.

Images 3a/b, which are satellite images of Lake Baringo taken to show the distribution of the invasive plant species Prosopis juliflora over time (see 5.4.), also indicate quite clearly the different size of Lake Baringo in 1973 compared to 2008.

According to Aloo, there are two main factors that have contributed to the fluctuations in lake levels, namely siltation and damming. Siltation of Lake Baringo is caused by rivers and soil erosion. Rivers that feed the lake from the south naturally transport silt into the lake. Therefore the south side of the lake is the shallower end.
Flash floods during rainy seasons enhance this process of soil erosion. Further, the lake lies in a depression with loose soils which are washed into the lake when it rains. (Aloo 2004, 338)
Soil erosion itself is a natural process, but it can be accelerated by human activities. According to Odada et al. the erosion source in the Lake Baringo area is soil degradation due to intensive or inadequate agricultural practices and land use. The Pokot and the Njemps are not only fisher, but mainly pastoralists who keep larger herds of cattle "which do not match the carrying capacity of the grazing land" (Odada et al. 2005, 42). As a consequence, there are not only problems with overgrazing, but also with increased soil erosion and siltation in the rivers and the lake. Especially during the rainy seasons "there is a lot of erosion on the land because of the livestock, which are kept near the shorelines", as Tugen fisher Joseph Chesire explained.
However, it should be mentioned that there is an ongoing controversy about the cause of and the concept behind overgrazing and land degradation, especially between different scientific disciplines. According to Homewood and Rodgers, ecologists see the process of overgrazing "as stemming from mismanagement inherent in traditional patterns of communal land tenure combined with individual herd ownership" (Homewood et al. 1988, 111), whereas social sciences tend to attribute overgrazing to external constraints, "such as compression due to the loss of rangelands to other forms of land use, or break down of traditional control under outside influences" (ibid). For the Baringo district the authors draw the following conclusions about the existence of overgrazing in the area:

> *In Baringo the Tugen Hills and Plateau are seen as 'overgrazed' because they have sparse, mainly thornbush vegetation, with high run off soil erosion rates – all due primarily to climate and geomorphology. The Njemps Flats are 'overgrazed' because they have sparse vegetation cover (again the inevitable result of edaphic conditions) and the proportion of grass cover varies with fluctuating stock densities and grazing pressure. The productive swamps grasslands are 'overgrazed' not because there is any problem of environmental degradation (whether through pastoral use or natural agents) but because at the peak of drought conditions the swamp is temporally grazed down to a level whereby cattle can no longer benefit (Homewood et al. 1988, 127).*

It can be said that the Homewood et al. see causes for land degradation and therefore soil erosion primarily related to the climatic and edaphic conditions of the area. Secondly, they see overgrazing as a temporary occurring phenomenon which has become a "self-

reinforcing concepts, with counter examples not infrequently suppressed for political reasons" (Homewood et al. 1988, 111).
Other reasons mentioned which seriously impact the water levels of Lake Baringo are damming and river diversion. River Endao, one of the main rivers draining into Lake Baringo, has been dammed to create the Chemeron Dam whose water is being used for the Endoa Irrigation Scheme where crops like maize, onion and tomato are being grown (Aloo 2004, 338). The Perkera and Molo rivers have not been dammed but they have been diverted for agricultural purposes around Marigat and Bogoria areas (ibid). When I met Kale Cheptalam, a smallholder, I asked him to draw a map of all irrigation schemes in the area and to indicate how and if they are connected to Lake Baringo. The map[4] confirms Aloo's information on the rivers Endao, Perkera and Molo and shows that Perkera, which Cheptalam marked as "permanent river", supplies water to the Perkera Irrigation Scheme near the Marigat Township. Those irrigation farms for cash crops in the upper reaches of the rivers entering Lake Baringo have severely enhanced the drying out of the rivers and thereby they have had great impact on the water levels of the lake (Lwenya et al. 2010).
During conversations with the fishermen they repeatedly stated how much higher the water level is now compared to a few years ago and that these conditions have led to a recovering fish population which will be discussed in the following chapter. Image 2a/b shall demonstrate the water level of Lake Baringo as witnessed during fieldwork. Image 2a was taken on the study site, the red arrows indicate where the lakeshore ran before 2012. Image 2b was taken in Kampi ya Samaki – here the dead trees in the water illustrate where there must have been lakeside land previous to the last big rains.

Images 2a. Water level of Lake Baringo during study period.
Study site: Ngenyin Beach
Source: Deichsel fieldwork March 2013

[4] Map can be found in the appendix section

Images 2b. Water level of Lake Baringo during study period.
Kampi ya Samaki
Source: Deichsel fieldwork March 2013

5.3 Fish stock

As discussed in the previous section, all components of an ecosystem can be understood as factors that condition each other. Hence, it can be assumed that the fish production in Lake Baringo and high or low water levels are related. The fishermen of Ngenyin Beach gave quite a specific account of how the fish stock has been developing since the late 1960s:

> *I had my first child in 1968 and then the number of fish was still very high. There were very many fish in the lake. Ten years later, that is 1978, the number of fish went down* ((Interview with Samuel Kimayo on 23 March 2013) 2013).

> *I started [fishing] around 1984 and the fishing was very excellent then, we had a lot of fish. We had different types of fish: Tilapia, Barbus, Clarias [...] I was fishing Tilapia and Barbus the most* (Interview with Michael Kangogo on 23 March 2013).

> *In 1994 the lake was brown […]. The number of fish, Tilapia and others was not completely down yet at that time. The population that were there, were mostly the lungfish, then come the catfish and Tilapia and then the Barbus. In that order* (Interview with Joseph Chesire on 23 March 2013).

> *I can tell you that the fishing is excellent during the rainy season like this. And when we find grass all around the lake. Those years were the years when I was starting until 2000. In 2004 we started getting very little fish and Fishery ministry even closed the lake. From that time [2006] the number of lungfish we caught increased* (Interview with Michael Kangogo on 23 March 2013).

The amount of fish caught at a certain point in time can be translated into a chart which gives a good visualisation of fish stock fluctuations as experienced by the fishermen. It should be noted here that the chart is based on approximate values.

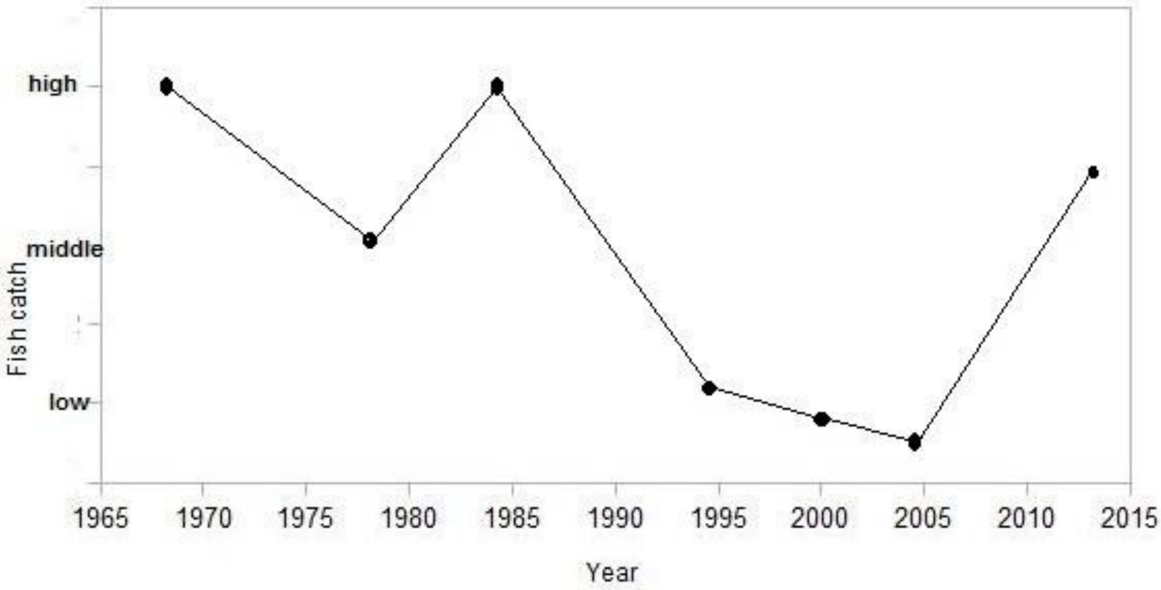


Figure 4. Trend of fish production in Lake Baringo based on fishermen's experiences
Source: author's rendering (Deichsel fieldwork 2013)

Years with high numbers of fish in the lake were therefore 1968, 1984 and 2012/13. Very few fish could be caught during the years 1994 to 2004. Looking at the fishermen's description of water levels in the previous section, it can be reasoned that high numbers of fish were caught during years with high water levels. One explanation for the relation between decline of water and the decline of fish stock is, as Samuel Kimayo explained, “when the water goes down, there is no breeding space for the fish, because they have nothing to feed on” ((Interview with Samuel Kimayo on 23 March 2013) 2013).
Another reason why low water levels impact the fish population, is the decrease in water quality. The fishermen pointed out to me that at times with little fish stock in Lake Baringo, the water had a muddy brown colour and that the lake is much clearer now. According to Odada et al. the main concern in relation to water quality conditions of Lake Baringo is turbidity. The authors relate the turbidity of the lake to high rates of soil being washed into the lake. Turbidity is further linked to water transparency (Odada et al. 2005). A physiochemical analysis of the lake, which was carried out during a period with low water levels (June 2001-May 2002), showed that the physical conditions of Lake Baringo were characterised, then by high temperature and low transparency as well as by a high pH-level (ibid). Douglas Limo, employee of the Department of Fishery. In Kampi ya Samaki, explained that “[...] in 2001 the water went 7-8 meters off shore! The water temperature was

so warm. All the fish died because of the low level of oxygen in the water" (Interview with Douglas Limo on 14 April 2013). It can be reasoned that a muddy brown colour of lake water functions as reliable indicator for unfavourable water conditions to the fishermen. And that these conditions reappear each time the water decreases below a certain point.

Alongside the change of fish population, over time the species composition of the lake has also been changing. Fish species that have appeared or still appear in Lake Baringo are Tilapia (Orechromis niloticus), lungfish (Protopterus aethiopicus), catfish (Clarias gariepnus), Barbus (Barbus intermedius) and Labeo (Labeo cylindricus) (Odada et al. 2005). In 1958, when the water level was very low, the fish population of Lake Baringo was sparse even to the extent that fish from outside were brought to Lake Baringo in order to rehabilitate the fish population. Fisherman Samuel told me about "one British man, known as Roberts[5] and he went to Naivasha to bring fish again to this place" (Interview with Samuel Kimayo on 23 March 2013).

He further explained that the lungfish, a non-indigenous species, was introduced in 1972 and that the numbers of lungfish and catfish (also nonindigenous to the lake) have since been increasing while the appearance of other species has been decreasing (ibid). Kangogo, on the other hand, stated that in 1984 he mainly caught Tilapia and Barbus, hence lungfish were not overly dominant yet. Eleven years later, the introduced species increased much more as Chesiere explained: "in 1994 the population that were there, were mostly the lungfish, then came the catfish and Tilapia and then the Barbus. In that order" (Interview with Joseph Chesire on 23 March 2013).

According to the fishermen's information, the species composition of Lake Baringo during fieldwork was as follows:

1) Lungfish (non-indigenous);
2) Catfish (non-indigenous);
3) Tilapia and Barbus, "which have decreased compared to the early years" (Interview with Samuel Kimayo on 23 March 2013); and
4) Labeo, "it is rarely there, it is nearly extinguished" (ibid).

Since the species composition has been changing, the fish's whereabouts and their migration patterns are important knowledge for the Tugen fishermen. In order to get continuous catch results the fishermen need to follow the fish. "If you want more fish, you have to go very far", Michael Kangogo explained (Interview with Michael Kangogo on 23 March 2013).

[5] David Roberts was an Australian-born British man who came to settle at Lake Baringo in 1948. He and his wife Betty built a lodge and fisheries by the lake. Roberts' Camp exists until today and is a popular camp site with tourists (The Safari and Conservation Company 2010).

Barbus and Tilapia are surface-feeders who breed in the more shallow south side and east side of the lake. In those areas they can find algae to hide and lay their eggs. South and east side of Lake Baringo are shallower, because it is there that the rivers discharge into the lake and bring soil. Catfish and lungfish are carnivorous bottom-feeders which tend to follow their food (i.e. Barbus and Tilapia). Labeo prefer rocky areas, which are located on the deeper north side "but we have very very few of them today" (Interview with Michael Kangogo on 23 March 2013).
During low lake levels, the Tugen fishermen temporally have to move to the south or east shore of Lake Baringo. The west side, their usual fishing territory, does not provide enough food for the fish during drought, thus the fish migrate further away. The fishermen's unmotorised boats do not allow them to expand their fishing radius, which is why they need to relocate:

> *When we go to the east shore we have to camp. And it's dangerous for us – there are many mosquitoes and we tend to get malaria. So that's why we decided to come back to the west shore, it's also near our homes and since the number of fish is steady here now, too* (ibid).

5.4 Introduced plant species: Prosopis juliflora

Prosopis juliflora is a perennial deciduous thorny shrub or small tree native to the Americas, which was introduced to the Baringo District and other parts of Kenya by the Kenyan government in the 1980s. After prolonged droughts in the 1970s, the drylands of Baringo District were severely degraded, which led to an extensive vegetation loss. Hence, there was an urgent need for rehabilitation through drought tolerant species. Trees from the Prosopis genus were chosen to grow because they had shown great potential in the rehabilitation of degraded lands, such as in the Bamburi cement quarry mines in Mombasa (Muturi et al. 2010, 629). It was intended to ensure self-sufficiency in wood products, in order to make the environment liveable, and to secure the existing natural vegetation from exploitation by rising human populations in the Baringo District (UNEP et al. 2009, 104).
The Prosopis distribution in the Baringo District is generally limited to the Marigat Division which is located south of the lake. Nevertheless the plant has spread rapidly causing problems for traditional pastoral livelihoods by blocking pathways, altering river courses, taking over farmlands, and suppressing other fodder species (see images 3a/b) (UNEP et al. 2009). Additionally, when goats eat the pods from the bushes the high sugar content damages their teeth. The plant has therefore been ascribed as invasive with the following characteristics:

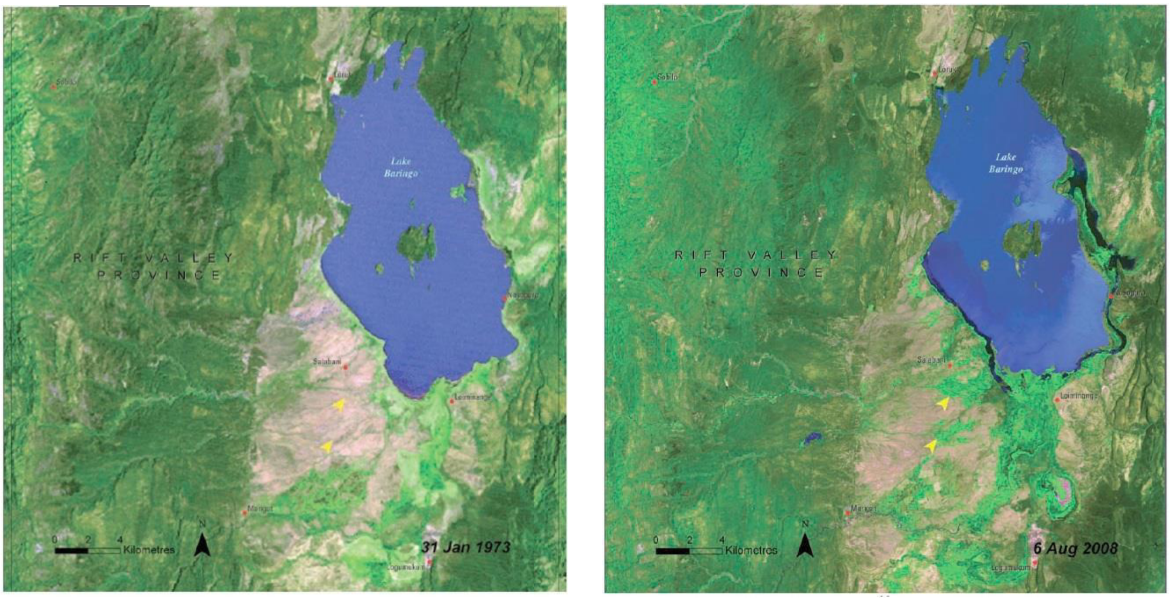
> *Characteristics for invasive species include rapid growth rates, extensive dispersal capabilities, large and rapid reproduction output and broad environmental tolerance.*

One important reason for their invasive behaviour is their outstanding viability under extreme conditions (Geesing et al. 2004, 37).

One reason for the fast spread of Prosopis juliflora is that it produces many small seeds that can form inactive seed banks. The seeds can then germinate when favourable conditions appear through disturbances such as flooding or rainfall (Geesing et al. 2004). Heavy rains in the area make seeds fall from the trees and the following flooding ensures widespread dissemination of the seeds.

Another major reason for the rapid spread is that goats eat the sweet-tasting mature pods of the plant and deposit the seed with their faeces at some distance from the parent plant. “This way the faeces might also serve as fertilizer to seedlings in an initial stage of establishment” (Andersson 2005, 22). In his work Andersson further observed that Kampi ya Samaki was one of the areas especially affected by the spread of Prosopis:

In Kampi ya Samaki P. juliflora had formed a dense population at the shore of Lake Baringo. The trees were up to 6 metres high, multi stemmed and had grown even into the lake. Further up from the shore P. juliflora became less dense and the last tree was seen 1100 metres from the shore of the lake (2005, 17).



Images 3a/b. Satellite image of Prosopis distribution in Baringo District 1973 & 2008
Source: UNEP & DEWA 2009

As portrayed above, the plant is mainly known to have a negative influence on the research area, especially for pastoralists. However, when conversing with Joseph Chesire (45), a Tugen fisherman, he described a different experience with Prosopis. Initially, Chesire confirmed the changes the plant had brought to the lake environment.

> *The introduced species of trees do have an impact on the lake. Not that they take a lot of water, they are actually an advantage to the lake* (Interview with Joseph Chesire on 23 March 2013).

But he continued to point out positive aspects that he attaches to the introduction of the plant.

> *And these trees, they grow along the shores of the lake, they tend to prevent the silt from being washed into the lake* (ibid).

As further research has shown, Tugen fishermen perceive siltation as one of the major hazards to their lake. Sediments washed into Lake Baringo are thought to be responsible for decreasing water levels. Consequently, Joseph Chesire stated, that the spread of Prosopis juliflora is helping to keep the water level stable.

> *That's one of the reasons why we say the water is increasing* (ibid).

Working with the technique of card piling, it became evident that the majority of Tugen fishermen of Ngenyin Beach do not classify Prosopis as a threat. On the contrary, eight out of ten fishermen questioned ranked Prosopis as “least hazardous to the lake”, and two ranked the plant as “less hazardous to the lake” (see figure 1a). Prosopis was never associated with the group “most hazardous to the lake”.

5.5 Hazards to the lake

In the previous section we learnt that – contrary to expectations – Prosopis juliflora is not perceived as a hazard to Lake Baringo by the fishermen. This shows that the fishermen's reality of the lake is different from the reality of pastoralists or biologists. Thus, it becomes apparent that the fishermen's perception of (hazards to) Lake Baringo is manifested, as Nduru et al. suggest (see 3.2), in the characteristics of the Tugen fishing community. In addition to what Ndurur et al. mention as community characteristics that influence hazard perception, I am suggesting that the community's everyday needs further affect what is or is not perceived as a hazard.

Through the process of card piling it was intended to capture hazards to Lake Baringo as perceived by the Tugen fishermen. The fishermen were individually asked to allocate 10 terms to three categories, namely “most hazardous”, “less hazardous”, and “least hazardous”. Those terms were taken from the previously conducted unstructured interviews after a first approximate analysis. Figure 1b shows that *chemicals*, *crocodiles*, and *drought* were most prominent in the category “most hazardous”. Figure 1a reveals that 100% of the participants perceived *drough*t and *crocodile*s as major hazards, 90% saw *che*micals, and 70% *other fishermen* as a major threat. In category “less hazardous”, the ranking results were more diversified. *Rivers* with 60%, and *human population* with 40% were allocated most numerous to this category. As “least hazardous” we had *rainy season* (100%), *catfish* (90%) and *Prosopis* (80%).

In a second step, the fishermen were asked to gradually rank all terms they had allocated to the category “most hazardous”. This meant that each participant created as many sub categories as he had allocated terms to the main category “most hazardous”. For example, Christopher Kibawen (I10) allocated 6 out of 10 terms to the category “most hazardous”. Therefore he was asked to gradually rank all 6 terms and thereby he created 6 sub categories. Samuel Kimaiyo (I1) only mentioned 3 terms for the category “most hazardous”, which meant for him to rank those terms and thereby establish 3 sub categories. This step was chosen in order to analyse the main hazards in more detail. The evaluation of the second ranking process revealed that *drought* (50%), *chemicals* (40%), and *crocodiles* (10%) were ranked as “most hazardous” (see figure 2a). 60% of the participants thought *crocodiles* were 2nd-most hazardous, and 30% ranked *other fishermen* as 3rd-most hazardous. Groups 4th-most and 5th-most hazardous were too diversified to read clear results, and only one person (I10) had 6 terms to rank.

The analysis of the card piling processes shows that the fishermen allocated a term to a category of hazards to whether or not a term was understood as having an impact on fishing outcomes. This observation is also confirmed by looking at the category “least hazardous”. *Rainy season* (100%), *catfish* (90%) and *Prosopis* (80%) were allocated most numerous to this category. In sub chapter 5.4 it was already discussed that the spread of Prosopis is mainly known to have a negative influence on the research area, especially for pastoralists. However the fishermen of Ngenyin Beach do not see the plant as a threat to the lake environment. This is because the plant is not understood as a danger to their day-to-day fishing routine. The fishermen further saw *rainy season* as “least hazardous” to the lake environment. Rains in the semi-arid Lake Baringo area are erratic, yet they can be very heavy and thus cause flooding. These floods can affect larger settled areas around Lake Baringo and submerged crop fields and pasture (NDMA 2013). For the lake, more specifically for the fish stock, rainy seasons are positive, as fisherman Samuel Kimayo explained:

> *Since the water level has risen these days, there is enough breeding space – and I would like to see how it [fish population] will change again* (Interview with Samuel Kimayo on 23 March 2013).

Concluding it can be said that these findings show that for the Tugen fishermen hazards to the lake equate with hazards to their fishing business.

To return to the hazards perceived as most damaging, *drought*, *chemicals*, *crocodiles* and *other fishermen* will be considered in more detail. For this purpose, statements made in the interviews will be connected with one another leading to a researcher's interpretation.

Drought

For the Tugen fishermen the term drought stood for decrease of water level, followed by decline in fish stock, resulting in loss of income sources and means of livelihood. The harsh climatic conditions and high dependency on climate sensitive natural resources in the Baringo District have increased vulnerability of the resident communities to recurrent droughts (Ogola et al. 2011, 4225). When Joseph Chesire was asked what in his view endangered fishing, the fisherman replied:

> *Mainly the environment, the change of the weather endangers our fishing. During drought seasons [long droughts over years], the breeding space for the fish disappears which contributes a lot to the decline of fish* (Interview with Joseph Chesire on 23 March 2013).

That is why the term *rainy season* was never mentioned as "most hazardous" or "less hazardous" during card piling, even though heavy rains can have disastrous consequences on the study area. However, those consequences (like loss of land or livestock) are not seen as threatening to the fishermen's livelihood.

Chemicals

The term chemicals was meant as a synonym for various forms of water pollution. During the interviews, however, the fishermen merely talked about chemicals from the irrigation schemes near Marigat which they see as main cause for water pollution. During a conversation with Douglas Limo, employee of the Department of Fishery, he further pointed out that waste-water from tourist accommodations along the shorelines of Lake Baringo was also directly drained into the lake. Yet, the impact of waste-water on the water quality is little compared to the impact of chemicals (Interview with Douglas Limo on 14 April 2013).

Crocodiles

The topic of crocodiles is another good example of how the fishermen evaluated hazards according to whether or not they influence their fishing business. During card piling the term crocodiles was primarily allocated to the category "2nd-most hazardous". Looking at the statement made during interviews, it becomes clear that the danger regarding crocodiles lies in what fisherman Kimayo called the "fishermen-crocodile conflict":

> *When the fishermen go and fish, they tend to put their nets near the surface and when they take the fish, the crocodiles swim around and they take the fish* (Interview with Samuel Kimayo on 23 March 2013).

Crocodiles clearly are a threat to the fishermen, as they literally rob the fishermen's source of livelihood. Yet, crocodiles cannot be seen as a disturbance to the lake's natural balance.

Other fishermen

Other indigenous communities living in the basin area are the Pokot and the Njemps. The Pokot do their fishing in the northern part of the lake. The Njemps are in the eastern and southern part and on the islands. When the Tugen fishermen complained about other fishermen as a hazard to the lake, they referred to the Pokot community from the north side of the lake. The Tugen fishermen blame the Pokot to use under-sized (small-mesh) fishing nets which cause decline in fish stock, since fish are not given the opportunity to reproduce. Follow-up questions then revealed, however, that according to the Tugen fisher the Pokot no longer use under-sized fishing nets. This leads to the assumption that there must be another reason for the dispute.

6 Discussion

The analysis of raw data in chapter five clarified how the fishermen interact with the lake and its environment. Furthermore it was possible to identify as well as catalogue the hazards to this specific environment as perceived by the fishermen in question. As a research method unstructured interviews were utilised with the intention to slowly enter the field. This way the research could be guided by local knowledge: by pointing out topics related to environmental change of Lake Baringo informants helped to focus and to structure this study. As a second method card piling helped to evaluate those experiences, because it was possible to classify specific experienced hazards through a two-stage ranking process. By way of a reminder, the three objectives of this case study are: (1) to explore local knowledge of Tugen fishermen on the ecosystem of Lake Baringo, (2) to analyse the fishermen's understanding of hazards to the lake environment and (3) to develop a form of hybrid-knowledge by combining fishermen's knowledge with other sources of scientific data. The associated research questions posed at the beginning of this study will be recapitulated and scrutinised by combining the processed data with the theoretical concepts of local knowledge, hazard, hazard perception and environmental change.

1a) What changes have Tugen fisher been observing over time regarding the lake, fish stock, and the adjacent environment?

The Tugen fishermen have vast knowledge, especially on the ecological changes such as water level, decline in sizes and siltation of the lake. Each event was stated with exact year date reaching back to when a fishermen started his work. As Wainwright[6] notes, our perception of environmental change is generally guided by experience (2011, 14). Since the fishermen live by the lake year after year, the old members of the Tugen community can draw on decades of experience. These experiences are kept in the collective knowledge of the fisher community and they also shape their perception of environmental change. It is argued, however, that beyond the length of a single lifetime, humans find it increasingly difficult to perceive changes because they rely on the assimilation of information that is much more indirect (Wainwright 2011, 14). During conversations the fishermen did not talk about environmental events they had not experienced themselves – thus the knowledge they shared was very direct, which demonstrates accuracy or completeness of the information given.
Over the course of data analysis, the year dates given by the fishermen regarding lake levels were translated into a graph together with data presented by agricultural engineer J. Onyando (in Odada et al. 2005) (see figure 3). First of all, what is striking about this graph

[6] Presented in sub chapter 3.3 Environmental change

is, that the fishermen's information dates back further than the data Onyando used for his presentation. This is the basis for the second piece of noteworthy information which can be taken from the graph: the fishermen's observations of the last 55 years express periodic trends, whereas Onyados calculations led to be a prediction of constant downward trends regarding the lake level. The fishermen are very aware of the repetition of lake circumstances, as fishermen Samuel Kimayo verbalised during the interview. The unusual high lake level during the case study was compared to what he had experienced in 1961.

> *Compared to the water level we are having now, this is a repeat of 1961, it is exactly the same level as then. It's a repeat from 50 years ago* (Interview with Samuel Kimayo on 23 March 2013).

Also the very low water level of 2000 was described in context.

> *In the year 2000 the lake was almost completely dry – again a repeat from 50 years ago* (ibid).

Raymond et al. suggest that it is time to develop user-inspired and user-useful management approaches for the management of environmental problems[7] (Raymond et al. 2010, 1766) thus, recognising the value of the fishermen's knowledge on the changes of Lake Baringo could be a step towards reaching this goal as this case study has shown the Tugen fishermen's information was accurate in content as well as in chronology.

Alongside the lake level, the fishermen further mentioned recognisable changes of the Lake Baringo fish stock. When correlating the water levels described by the fishermen and the information they gave on the fish population, it can be reasoned that when the lake level is high, the number of fish is also relatively high. According to the fishermen's information, years with high numbers of fish were 1968, 1984 and 2012/13. Very few fish could be caught during the years 1994 and 2000. Not only the number of fish, but also the species composition of the lake has been changing over time. Non-indigenous fish species like lungfish and catfish were introduced to the lake which affected indigenous species such as Barbus, Tilapia and Labeo. Lungfish and catfish are carnivorous fish who endanger the other species – the fishermen use Barbus and Tilapia as bait to catch lungfish and catfish. This demonstrates the fishermen's knowledge about changes of species composition as well as where and when to catch specific species. According to the fishermen's information, the species composition of Lake Baringo during fieldwork was (1) lungfish, (2) catfish, (3) Tilapia and Barbus, (4) Labeo.

For the adjacent environment of the lake two aspects are mentioned by the fishermen, namely Prosopis juliflora and siltation. In the literature Prosopis is often described as an invasive plant with many negative effects on the area, especially for pastoralists. The

[7] Presented in sub chapter 3.1 Local knowledge

fishermen, however, understand the plant as useful for the prevention of soil erosion and therefore as responsible for the increasing water level of the lake. The plant was introduced to the Baringo District in the 1980s for the rehabilitation of degraded land. Therefore, the introduction of Prosopis was thus a human intended change of the environment, that had a direct impact on the landscape and, according to the fishermen, an indirect impact on Lake Baringo's water level. Regarding environmental change Wainwright[8] argues that "[o]ften, the most important effects are those where human activities have caused feedback in other parts of the environmental system" (2011, 14). The introduction of Prosopis could be viewed as a positive example for this claim – at least in regard to the water level of Lake Baringo.

The topic of siltation was not as relevant for the fishermen as were water level or fish stock. They viewed sediments carried to the lake by the rivers as a hazard to the lake, more precisely as a hazard to the lake level. During card piling the term rivers was associated with inflow of water as well as with siltation. *Rivers* was ranked most numerous as "less hazardous" (see figure 1b) and therefore not seen as a major threat. Besides *rivers*, the fishermen blamed livestock, which pastoralists graze near the shorelines, as the main reason for soil erosion and consequent siltation of Lake Baringo. This brings us to the next research question, the issue of interpretation of those environmental changes.

1b) How do they interpret environmental changes?

The content analysis after Mayring has shown that water level changes of Lake Baringo were mainly attributed to the climatic conditions of the area. Long droughts were therefore understood as the main factor for the decrease of lake water. The fishermen have further been observing that weather patterns have become less predictable and thus make it more difficult to predict when the necessary rains would arrive.

> *I know the lake since I was a young boy, I can date it back to 1958. Then the lake fluctuated with seasons* (Interview with Samuel Kimayo on 23 March 2013).

The fishermen did not mention the concept of global warming when talking about the lake levels. However, according to the Kenyan National Environmental Management Authority the warming of the climate in the region is a) apparent and b) it is going to be the biggest challenge there, since the area is already characterised by dryness and erratic rainfall. NEMA therefore points out that it is necessary to find strategies for livelihood diversification for the area. This is because locals can no longer rely on expected returns from fishing, agriculture or other sources of income purely based on a *predictable* environment.

Changes in fish stock were linked to the water quality of the lake. The colour of the lake water thereby functions as a reliable indicator for the water quality. For the fishermen a

[8] Presented in sub chapter 3.3

muddy brown water colour stands for unfavourable water conditions: when the water is brown, the water level is low, as a result the water temperature is high and the fish stock decreases. The fishermen therefore directly link the quality of the lake water to the lake's water level.

> *At that time when I started fishing the lake was not like it is today. Even the colour of the water then and now is different. In 1994 the lake was brown. At that time there wasn't a lot of water in the lake* (Interview with Joseph Chesire on 23 March 2013).

This case study has further shown that the fishermen not only are aware of the changes in their immediate environment, but they also want to point out these changes to outsiders. During conversations with the Tugen fishermen, it was explained to me on several occasions that what I saw, namely a blue-green water which appeared clear, was not the *usual* condition of Lake Baringo.

> *Since the big rains [after 2006] the water level rose and as the silt sank and not so much silt now is washed through the rivers. That is why the lake is clear today compared to when I started* (ibid).

Additionally, the conditions I witnessed were perceived as an enormous relief for the fishermen who had been experiencing a decline in fish stock since 1984, i.e. since nearly thirty years (see figure 4).

> *Since the water level has risen these days, there is enough breeding space – and I would like to see how it [fish population] will change again* (Interview with Samuel Kimayo on 23 March 2013).

The changing conditions of Lake Baringo and its environment brought up the topic of hazard and hazard perception as formulated in the following research question.

2) *What are the hazards to the lake's ecosystem and how do fishermen evaluate them?*

As presented in table 1, the hazards that the fishermen associate with Lake Baringo cover a wide spectrum. From climatic/environmental conditions (terms are: *drought*, *rainy season*, *rivers*, and *crocodiles*) to purely human introduced hazards (terms are: *lungfish*, *catfish*, *Prosopis*, *chemicals*) and hazards caused by other locals (terms are: *other fishermen*, *human population* around the lake). During the first part of the ranking process, the fishermen were asked to allocate the hazard terms to three categories, namely "most hazardous", "less hazardous", "least hazardous", thereby assessing the threats according to their hazard potential. Figure 1a reveals that 100% of the participants perceived *drought* and *crocodiles* as major hazards, 90% saw *chemicals,* and 70% *other fishermen* as a major threat. In category "less hazardous", the ranking results were more diversified. *Rivers* with

60%, and *human population* with 40% were allocated most often to this category. As "least hazardous" we had *rainy season* (100%), *catfish* (90%) and *Prosopis* (80%) The second card piling process allowed a closer look at the threats which were associated with the category "most hazardous".

In the course of evaluating the two-stage card piling process in sub chapter 5.5, it became evident that for the Tugen fishermen, hazards to the lake equate with hazards to their fishing business. The topic of crocodiles supports this claim. As previously mentioned, during card piling the term *crocodiles* was primarily allocated to the category "most hazardous". The statements made during interviews showed that the danger regarding crocodiles lies in what fisherman Kimayo called the "fishermen-crocodile conflict":

> *When the fishermen go and fish, they tend to put their nets near the surface and when they take the fish, the crocodiles swim around and they take the fish* (Interview with Samuel Kimayo on 23 March 2013).

B.K. Paul [9] states that hazards and disasters should be viewed as "continuum of physical/environmental, social and technological systems" ranging from "extreme natural events to technological failure to social disruption to terrorism" (Paul 2011, 21). Especially "hazards as social disruption" apply for this case study as can be seen in the case of crocodiles. Crocodiles disrupt the fishermen's work routine and rob them of their source of livelihood. However, they are no disturbance to the natural balance of the lake. Crocodiles are therefore a threat to the individual fishermen as well as to the whole Tugen community. That is why they were commonly allocated to the category "most hazardous", and thus seen as a "potentially damaging phenomenon" (Pelling 2011, 5).

When the fishermen were asked, what challenges they see for future generations of fishermen, Samuel Kimayo answered:

> *I don't foresee any different challenges for our future fishermen. If they are still using the same method of fishing they will have the same problems that we have now. For the future generation it would be better to look for different occupations, because it's a very hard job and it is challenging (Interview with Samuel Kimayo on 23 March 2013).*

Thus, it can be argued that the Tugen fishermen accept their work and living conditions have been shaped by hazards and that they expect those hazards to continue or reoccur.

3a) What official data is there regarding the changing environment of Lake Baringo?

Official data, meaning published studies, on the changing environment of Lake Baringo is plentiful. International organisations (UNEP, ILEC, Ramsar Convention, etc.), national governmental departments (MDMA, NEMA, NCPD, etc.), as well as independent scientists

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[9] Presented in sub chapter 3.2 Hazards and hazard perception

from all over the world have completed research work regarding this matter. All material consulted for this case study has been incorporated into the relevant chapter(s) in order to create a form of hybrid knowledge together with my own research results.

3b) In what way can Tugen local knowledge be incorporated in scientific research and therefore function as a complementing source of knowledge?

In my opinion and based on the experiences of this case study the answer lies in, the creation of forms of *hybrid knowledge*. Raymond et al. describe hybrid knowledge as "the new understandings which emerge through the integration of different types of knowledge (such as local and scientific) and/or through multi-, inter-, or trans-disciplinary research" (2010, 1769). Thereby it is important to make connections between local people's understanding and practices, and research and development approaches. Taken from the decision model by Sillitoe & Barr "for the incorporation of indigenous knowledge into development projects", the following aspects were helpful for creating this case study:

- Facilitating meaningful communication with local people;
- Understanding and valuing local people's knowledge and practices;
- Advancing participatory research to identify and tackle constraints more effectively; and
- Discussing with people the social, environmental and other consequences of any action (Sillitoe et al. 2004, 59).

However, the fundamental requirement for the integration of different types of knowledge is, however, to recognise that these different types of knowledge have equal value. Knowledge possessed by locals is often seen as inferior to scientific knowledge, which is, according to Nygren[10], a misinterpretation:

> *There was little recognition of the fact that in practice science is 'achieved' in much the same way as other forms of knowledge – through social construction and negotiation (Nygren 1999, 273).*

Through including local knowledge in scientific research, the local knowledge becomes accessible to a broader audience and can therefore function as reference for future research approaches. Furthermore, the integration of local knowledge is an important step towards a successful involvement of local stakeholders and marginalized communities.

[10] Presented in sub chapter 3.1

7 Conclusion

This case study sought to capture local knowledge possessed by Tugen fishermen on the environmental changes of Lake Baringo. It was intended to uncover the value of this knowledge for further research work as well as for environmental management approaches. For this study, local knowledge was regarded as a culturally and ecologically situated form of knowledge: through living in this environment, through dealing with changes and challenges within this environment and through observing them, the Tugen fishermen have developed an expertise of their own. The analysis of raw data revealed that the knowledge the Tugen fishermen shared was very direct, thus no uncertain comments were made, for example on future developments of the lake environment. This demonstrates accuracy or completeness of the information given. The chronology regarding past lake level developments and the changes in fish stock was especially detailed.

As for the assessment of hazards, it can be said that Tugen fishermen evaluate hazard potential according whether or not a threat impacts their fishing business. This result therefore supports Antweiler's claim who states that local knowledge "is not only cognitive, but entails emotive and corporeal aspects" (Antweiler 2004, 10). Yet, as other studies (also at Lake Baring) have shown, local communities are willing to adopt new environmental management approaches, if they have the potential to secure livelihoods:

> *A number of the lake basin briefs stated that the power of community-level participation is evident when the outcomes of participation are clearly and directly linked to an improvement in the livelihoods of participating communities. The Lake Champlain, Baikal, Baringo, Malawi/Nyasa, and Nakuru briefs all stated that local people would support interventions that will improve their livelihood security (ILEC 2005, 49)*

Overall, it should be noted that the results of this case study are based on one third of the Tugen fishermen of Ngenyin Beach who were involved in the survey. This might have occurred, because during the study period, it proved difficult to awaken the interest of more fishermen. And possibly because the outcomes of participation in this survey were not clearly enough linked to an improvement in the Tugen's livelihoods.

Based on these survey results and with the knowledge that scientific findings are always interpreted by individuals who make sense of them in relation to what they know and to what they have experienced in their own past, I am recommending the following…

…for future research:

- A comparative study focusing on the local knowledge of the two other local lake communities (the Njemps and the Pokot) could complement the findings of this case study and reveal differences as well as similarities, especially in regard to hazard perception;
- Within the Tugen community, investigating the local knowledge of the Tugen women, who are not involved in fishery, could give a different perspective on environmental changes to Lake Baringo as well as on the challenges the Tugen face in their daily life.

…for future environmental management approaches at Lake Baringo:

- It became apparent that Tugen local knowledge is a rich and accurate source of information which is easily accessible;
- This source of knowledge should be used for future environmental management approaches at Lake Baringo, because it reveals the actual challenges a community faces when relying on an unpredictable environment for their livelihood. This would open up opportunities for integrative management, considering all components of an ecosystem, namely nature and men.

To round up this work I will finish with a little anecdote. Right at the beginning of my field work I asked fisherman Samuel Kimayo: "tell me about your lake, what is most important to you about it?" His reply was very fitting to what I was to experience in the course of my research, he said:

> *What I can tell somebody is that we love our lake. Our lake is beautiful, it's like our farm, it's where we get our daily living – whether in bad times or in good times, it is our place* (Interview with Samuel Kimayo on 23 March 2013).

His statement shows once more that the Tugen fishermen work and live closely with the lake. Their knowledge on Lake Baringo is therefore based on extensive experience and observation; these are two crucial components of any form of reflective knowledge acquisition and transfer.

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Appendix

Coding sheet, Samuel Kimayo (I1)

Main category	Sub category	Text passage	Coding rule	Note
1. Description of lake in the past and today				
	1.1 Fluctuating lake level	I know the lake since I was a young boy, I can date it back to 1958. Then the lake fluctuated with seasons. Most of the time the lake was very low, lower than it is today	when lake level as such is mentioned, otherwise 1.3 (climatic situation)	
		1958 The lake was very very low, very low at that time – compared to this level now.		
		So, the water level increased from 1961 until 1965.		
		From 1965 onwards the level went guardedly down, not increasing at all, just went down – until the year 2000.		
		In the year 2000 the lake was almost completely dry – again a repeat from 50 years ago.		
		The level remained that low until 2006. In 2006 the water was a little bit higher. The lake then gradually increased with the rains that kept coming. Unit the year 2012 when the lake exploded again to the same level of 1961.		
	1.2 Fish stock	There was one British man, known as Robert, and he went to Naivasha to bring fish again to this lake. That was in 1958 when Roberts brought the fish again to this place.		

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Coding sheet, Samuel Kimayo (I1)

	1.3 Climatic situation	Three year later, 1961, there were very very big rains and the lake level increased a lot. Compared to the water level we are having now, this is a repeat of 1961, it is exactly the same level as then. Its a repeat of from 50 years ago		Also 1.1
		In 1965 there was a very very big drought		
	1.4 Water quality	///		
2. Description of fish stock in the past and today				
	2.1 Change in fish stock	I had my first child in 1968 and then the number of fish was still very high. There were very many fish in the lake		
		Ten years later, that is 1978, the number of fish went down.		
	2.2 Reasoning for change	1968: The reason why we had so many fish in the lake during those years is the population. There were quite a few fishermen in comparison to now. Since the number of fish was very high we continued fishing	code for personal reasoning to 2.1 (change in fish stock)	
		The factor that was contributing to the number of fish, is the decline of the water. So when we have droughts, and the water level goes down, there is no breeding space for the fish, because they have nothing to feed on.		
	2.3 Tilapia	it has decreased compared to the early years		
	2.4 Barbus	decreased compared to the early years.		
	2.5 Labeo	[…] which is rarely there, it is nearly extinguished		

	2.6 Lungfish	The lungfish is an introduced species, they introduced it in 1972. So the numbers of lungfish and catfish are increasing, the other species are decreasing.		**Also 2.7; 3.8**
	2.7 Catfish	///		
	2.8 Breeding space	But, since the water level has risen these day, there is enough breeding space – and I would like to see how it will change again.		
3. Hazards to the lake and fishing business				
	3.1 Human population	According to me, so that is what I can see, the increase of human population around is disturbing to the lake.		
	3.2 Other fishermen	they use under-size fishing nets, hence they tend to catch under-size fish which could have been kept for breeding in the near future.		
	3.3 Decrease of water level	And also the environment, the decrease of the water at different times of the year	when lake level as such is mentioned, otherwise 3.5 (drought)	
	3.4 Crocodiles	Yes, they can have an impact, put the impact is small. When the fishermen go and fish, they tend to put their nets near the surface and when they take the fish, the crocodiles swim around and they take the fish.		
	3.5 Drought	///		
	3.6 Dams	///		
	3.7 Water pollution	///		
	3.8 Lungfish	///		
	3.9 Siltation	///		

Coding sheet, Samuel Kimayo (I1)

4. Change of fishing practice				
	4.1 Single hooks	In the early days, when I was young, we used to fish using lines with single hooks.		
	4.2 Fishing nets	The younger generations have fishing nets now. You can leave the net in the water the whole day and collect the fish then in the morning.		
	4.3 Long lines w many hooks	Also we have now long lines with many hooks to catch big fish.		
	4.4 Time as a business factor	So compared to the past, with one hook you spend the whole day on the lake and you only catch a few fish. The practice we do these days consumes less time and gives us a better result.		
		However, we still use the same style boats made from Balser wood.		
	Fishing routine	///		
	fishing ban	///		
5. Environment around the lake		///		
	5.1 Introduced species			
	5.2 Erosion			
	5.3 Livestock			

Coding sheet, Joseph Chesire (I2)

Main category	Sub category	Text passage	Coding rule	Note
1. Description of lake in the past and today				
	1.1 Fluctuating lake level	Since the big rains [after 2006] the water level rose and as the silt sank and not so much silt now is washed trough the rivers.	when lake level as such is mentioned, otherwise 1.3 (climatic situation)	**Also 1.5**
		The vegetation around the lake did also have an impact on the lake, yes. When the lake level went down the grass dried out		**Also 5.1**
	1.2 Fish stock	In 1994 the lake was brown, there were still fish in the water but mostly lungfish. The number of fish, Tiliapia and others was not completely down yet at that time.		**Also 1.1; 1.4**
		1994: The population that were there were mostly the lungfish, then come the catfish and Tilapia and then the Barbus. In that order.		
	1.3 Climatic situation	///		
	1.4 Water quality	1994: At that time when I started fishing the lake was not like it is today. Even the colour of the water then and now is different.		**Also 1.1**
		1994: At that time there wasn't a lot of water in the lake. And the water was very brown due to siltation.		**Also 1.5**
		That is way the lake is clear today compared to when I started.		
2. Description of fish stock in the past and today		///		
	2.1 Change in fish stock			
	2.2 Reasoning for change		code for personal reasoning to 2.1 (change in fish stock)	
	2.3 Tilapia			
	2.4 Barbus			
	2.5 Labeo			

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	2.6 Lungfish			
	2.7 Catfish			
	2.8 Breeding space			
3. Hazards to the lake [=fishing business]				
	3.1 Human population	///		
	3.2 Other fishermen	///		
	3.3 Decrease of water level	///		
	3.4 Crocodiles	///		
	3.5 Drought	During drought seasons [long droughts over yeas], the breeding space for the fish disappears which contributes a lot to the decline of fish.		**Also 1.2**
	3.6 Dams	///		
	3.7 Water pollution	///		
	3.8 Lungfish	///		
	3.9 Siltation	1994: Back then lot of silt was washed through the rivers into the lake.		
4. Change of fishing practice		**///**		
	4.1 Single hooks			
	4.2 Fishing nets			
	4.3 Long lines w many hooks			
	4.4 Time as a business factor			
	4.5 Fishing routine			
	4.6 Fishing ban			
5. Environment around the lake				
	5.1 Introduced species	The introduced species of trees do have an impact on the lake. Not that they take a lot of water, they are actually an advantage to the lake		
		And these trees, they grow along the shores of the lake they tend to prevent the silt from being washed into the lake.		
		That's one of there reasons why we say the water is increasing.		

Coding sheet, Joseph Chesire (I2)

	5.2 Erosion	Because during the rainy season, there is a lot of erosion on the land [...] So, a lot of silt is been washed into the water.		
	5.3 Livestock	Because during the rainy season, there is a lot of erosion on the land because of the livestock (goats, cows) which is kept near the shorelines		

Coding sheet, Michael Kangogo (I3)

Main category	Sub category	Text passage	Coding rule	Note
1. Description of lake in the past and today				
	1.1 Fluctuating lake level	///	when lake level as such is mentioned, otherwise 1.3 (climatic situation)	
	1.2 Fish stock	I started around 1984. And the fishing was very excellent then, we had a lot of fish.		
		We have different types of fish: we have Tilapia, Barbus, Clarias so we were catching a lot of fish.		
		I was fishing Tilapia and Barbus the most.		
	1.3 Climatic situation	I can tell you that the fishing is excellent during the rainy season like this. And when we find grass all around the lake. Those years were the year when I was staring until 2000.		Also 2.1
		In 2004 we started getting very little fish and Fishery ministry even closed the lake.		Also 4.6
	1.4 Water quality	///		
2. Description of fish stock in the past and today				
	2.1 Change in fish stock	From that time [2006] the number of lungfish we caught increased.		
	2.2 Reasoning for change	That was because the Tilapia didn't get there food near, so we rarely caught them anymore. So Tilapia could be found on the south side, so on the west side we could not get Tilapia.	code for personal reasoning to 2.1 (change in fish stock)	
	2.3 Tilapia	On the southern side you can find Tilapia. But Tilapia needs areas were we can get grass.		
	2.4 Barbus	///		

	2.5 Labeo	Those Labeo they need rocky areas, but we only have very very few of them today.		
	2.6 Lungfish	On the eastern side we have lungfish, because lungfish like mainly muddy places.		
		So the west side has lungfish.		
	2.7 Catfish	Clarias they also mainly feed in the muddy areas.		
	2.8 Breeding space	///		
3. Hazards to the lake [=fishing business]				
	3.1 Human population	///		
	3.2 Other fishermen	One are even the human beings. The other people are fishing the under-size fish – so the fish population will go down		
	3.3 Decrease of water level	When there's less water there is less food. So on the west side the food is very little, that's why we don't catch fish here.	when water level as such is mentioned	
	3.4 Crocodiles	And also the crocodiles are a problem because they eat all the fish.		
	3.5 Drought	///		
	3.6 Dams	Another problem is, when they close down the dams of the rivers which feed the lake		
	3.7 Water pollution	Also the factories that we have near the lake are a problem- Be cause of those chemicals come into the water of the lake. So the pollution of the water is a problem for fishing.		
		Yes they [chemicals] come from Marigat, form the irrigation areas. They are using the chemicals and they get washed into the lake.		

	3.8 Lungfish	And even the lungfish causes trouble – because of the lungfish the population of Tilapia goes down. Because there is no other fish that can eat lungfish, except the human beings.		
4. Change of fishing practice				
	4.1 Single hooks	///		
	4.2 Fishing nets	///		
	4.3 Long lines w many hooks	///		
	4.4 Time as a business factor	Most of the time we go out very far, we almost go 10 km out from here. If you want more fish you have to go very far.		
	4.5 Fishing practice	So I was fishing Tilapia one time and the next time Barbus. Because if you fish for Tilapia you get meat for Barbus: Tilapia was the bait for Barbas [lungfish].		
		Oh, we go out very far from this [west] side, because the fish are migrating. So we almost go 10 km out from here. If you want more fish, you have to go very far.		
		We are following the fish. That's why we go to the southern and the eastern side. So we find ourselves living in other areas [during low water level]		
		On the north side you find few fishes of all species.		
	4.6 Fishing ban	In 2004 we started getting very little fish and Fishery ministry even closed the lake.		
		Before 2004 the lake has been closed 1986, 1993 until 1997.		
5. Environment around the lake		///		

Coding sheet, Michael Kangogo (I3)

	5.1 Introduced species			
	5.2 Erosion			
	5.3 Livestock			

Coding sheet, Douglas Limo (I12)

Main category	Sub category	Text passage	Coding rule	Note
1. Description of lake in the past and today				
	1.1 Fluctuating lake level	Its not all that deep. On the southern side that is where the rivers run into the lake and bring a lot of silt, that's the sallower end. The northern part ranges from 12m to 14m depth.	when lake level as such is mentioned, otherwise 1.3 (climatic situation)	
		I remember in 2001 the water went 7-8m off shore! The water temperature was so warm. All the fish died because of the low level of oxygen in the water.		
	1.2 Climatic situation	///		
	1.3 Water quality	///		
	1.4 Siltation	On the southern side that is where the rivers run into the lake and bring a lot of silt, that's the shallower end		
2. Description of fish stock in the past and today				
	2.1 Change in fish stock			
	2.2 Reasoning for change		code for personal reasoning to 2.1 (change in fish stock)	
	2.3 Tilapia	Barbus and Tilapia are surface-feeders and they are using fishing nets for them.		Also 2.4
		Tilapia go to the shallower end to breed, because there are algae where they can hide and lay their eggs.		
		So of course catfish and Mudfish love to follow to where is a lot of their food		Also 2.4
	2.4 Barbus			

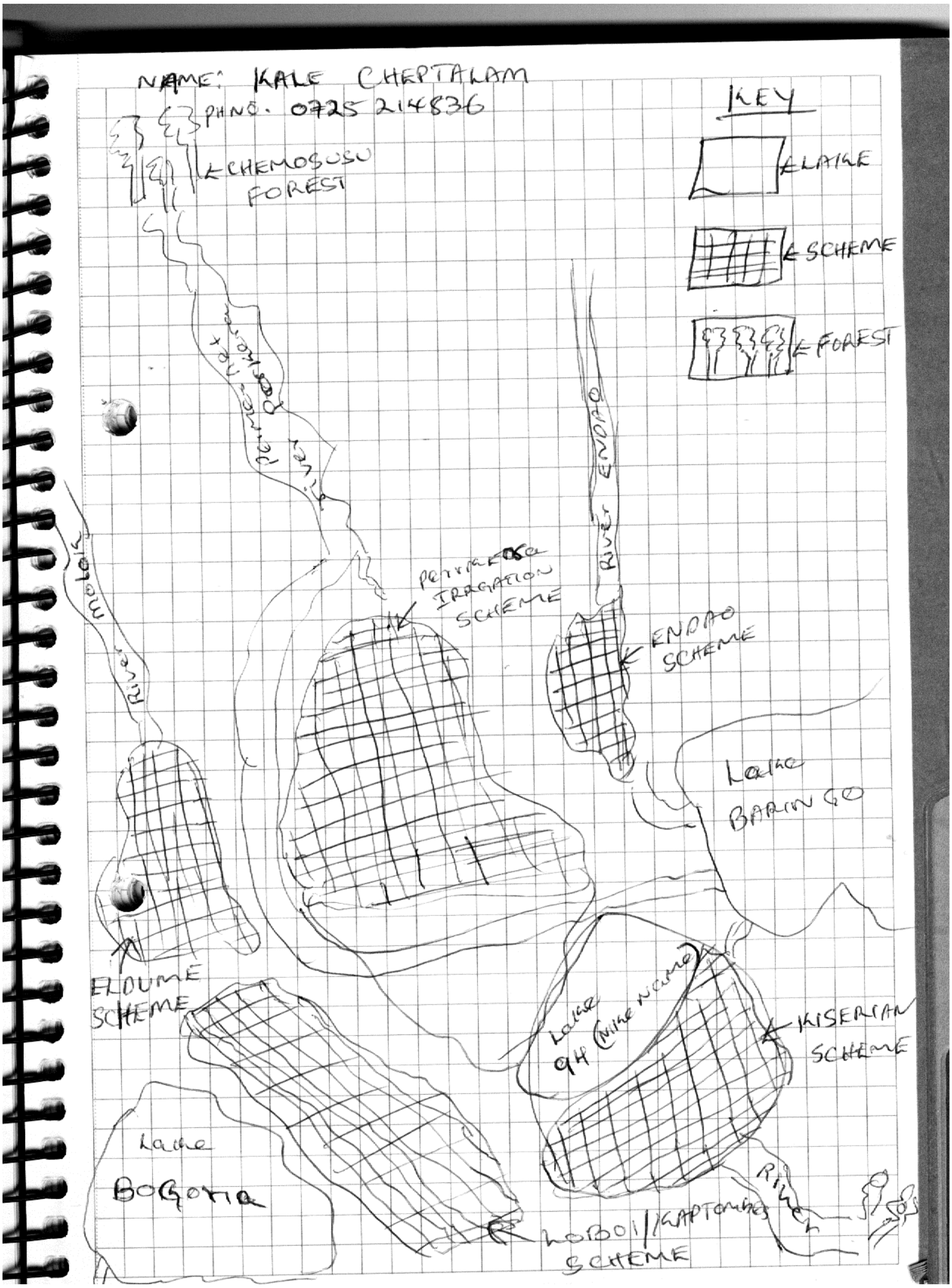
	2.5 Labeo	///		
	2.6 Lungfish			
	2.7 Catfish	We have catfish and Mudfish, they are bottom-feeders. You get them mostly on the lower part of the lake and the method of fishing is different from the one used for Barbus and Tilapia.		Also 2.6
		But still you can get catfish and Mudfish on the deeper side. It has to do with competition over food resources. When there is enough food you can find them in the deep end of the water		Also 2.6
	2.8 Breeding space	When they poison the crocodiles they can contaminate the breeding sides for the fish		
3. Hazards to the lake [=fishing business]				
	3.1 Human population	If you compare Kampi ya Samaki now and 40 years ago, it's completely different. The population in the town has been increasing enormously. Before the communities around the lake weren't big fish-eaters. But since the fishing business has increased, a lot of other people came in as traders, businessmen. And others came in to do the large-scale fishing. Kampi ya Samaki has become a commercial center		
	3.2 Other fishermen	///		
	3.3 Decrease of water level	When the water level was really low and that weed [Prosopis] kept growing along the shores of the lake. We had a lot of rain at the end of last year and the water level rises, up-marching the plants.	when water level as such is mentioned, otherwise 3.5 (drought)	

	3.4 Crocodiles	So they [Ministry of Fishery] patrol on the lake, also to see when people try to poison crocodiles		
		Lake Baringo is the only water source in the area. So people who live around the lake, the fishing communities also keep livestock. And the livestock usually goes to the lake to drink water and when they go into the lake they're being attacked by the crocs. So as a farmer you get nervous and the only way to get rid of the crocodiles is to poison them.		
		they lace fish to poison the crocodiles. The fish are cut one one side and the poison is put into the fish and it then gets fed to the crocodiles		
	3.5 Drought	///		
	3.6 Dams	///		
	3.7 Water pollution	Another hazard is human pollution. Lake Baringo has many tourist attraction sites and most sites have hotels, restaurants, lodges along the beaches. And the wast water goes directly into the lake		
		We have two permanent rivers that empty water into lake Baringo and that is the water farmers in Marigat are using to irrigate their farms. So, they normally spray pesticides on their plants and veggies they grow – that is tomatoes, onions, watermelon – to kill the insects that affect their crops. So when you have a lot of water in the river it carries the chemicals down into the lake.		

		And the chemicals affect the fish and the ecosystem of the lake. So the birds, the eagles and the fish. Because when the birds consume the fish they also consume the chemicals.		
		The catfish and the Mudfish are cannibal-fish, so they feed on Tilapia and Barbus. So you can imagine the impact.		
		And the chemicals enrich the kind of plant that germinate in the water. Because the chemicals are really rich on nutrients.		
	3.8 Lungfish	///		
	2.9 Siltation	///		
4. Change of fishing practice				
	4.1 Single hooks	///		
	4.2 Fishing nets	The Ministry regulates for example what fishing nets are ought to be used, so they regulate the gear used for fishing. The recommended size of nets is 3 inches, 3,5 to 4 inches so they get quit big fish.		
	4.3 Long lines w many hooks	///		
	4.4 Time as a business factor	///		
	4.5 Fishing routine	Also they have now have sub-divided the place. In the northern part of the lake, there is the Pokot community doing their fishing. You go to the eastern and the southern part of the lake and to the islands, there is the Njemns community. And on the west side there are the Tugens. I means the locals they arrange themselves		
	4.6 Fishing ban	///		

Coding sheet, Douglas Limo (I12)

6. Environment around the lake				
	6.1 Introduced species	We have the Prosopis juliflora, that's one of the weeds that really affected the fishing communities since it multiplied a lot in the area. Especially when they're putting their nets in the lake, so they get the weed stuck in the nets for those people who are fishing along the shore		
		Nile cabbage. It looks like (?) that is common in Lake Victoria and Lake Naivasha. But that one [Nile cabbage] is not so much a problem. Because it happens once during rainy seasons – it's not common, soft of. It keeps on shifting: it appears, then disappears, then appears, then disappears.		
	6.2 Erosion	///		
	6.3 Livestock	///		


NAME: KALE CHEPTALAM
PHNO. 0725 214836
CHEMOSUSU FOREST
KEY
LAIKE
SCHEME
FOREST
River Perkerra
River ENDAO
River molok
PERKERRA IRRIGATION SCHEME
ENDAO SCHEME
Lake BARINGO
ELDUME SCHEME
Lake 94 (nike name)
KISERIAN SCHEME
Lake BOGORIA
LOBOI/KAPTOMBES SCHEME
River

Data analysis of card piling process (Figures 1a & 2a)

Name (I4): Joseph Kipyekomen
Age: 48

Most hazardous	Less hazardous	Least hazardous
drought season	lungfish	prosopis
crocodiles	human population	rainy season
other fishermen	rivers	catfish
chemicals		

Ranking	Most hazardous
1.	drought season
2.	crocodiles
3.	chemicals
4.	other fishermen

Name (I5): Jonathan Chepsergon
Age: 40

Most hazardous	Less hazardous	Least hazardous
drought season	other fishermen	catfish
crocodiles	chemicals	rivers
lungfish		prosopis
human population		rainy season

Ranking	Most hazardous
1.	drought season
2.	crocodiles
3.	human population
4.	lungfish

Name (I6): Daniel Kiprop
Age: 15

Most hazardous	Less hazardous	Least hazardous
human population	lungfish	prosopis
rivers	other fishermen	catfish
crocodiles		rainy season
drought season		
chemicals		

Ranking	Most hazardous
1.	drought season
2.	human population
3.	rivers
4.	crocodiles
5.	chemicals

Data analysis of card piling process (Figures 1a & 2a)

Name (I2): Joseph Chesire
Age: 45

Most hazardous	Less hazardous	Least hazardous
lungfish	rivers	rainy season
other fishermen	prosopis	catfish
drought season	human population	
chemicals		
crocodiles		

Ranking	Most hazardous
1.	chemicals
2.	other fishermen
3.	crocodiles
4.	drought season
5.	lungfish

Name (I7): Dixon Rono
Age: 14

Most hazardous	Less hazardous	Least hazardous
chemicals	rivers	catfish
crocodiles		prosopis
other fishermen		lungfish
drought season		rainy season
human population		

Ranking	Most hazardous
1.	chemicals
2.	crocodiles
3.	other fishermen
4.	human population
5.	drought season

Data analysis of card piling process (Figures 1a & 2a)

Name (I8): Joshuar Kulai
Age: 35

Most hazardous	Less hazardous	Least hazardous
crocodiles	other fishermen	rainy season
rivers	human population	catfish
drought season	lungfish	prosopis
chemicals		

Ranking	Most hazardous
1.	drought season
2.	chemicals
3.	crocodiles
4.	rivers

Name (I1): Samuel Kimaiyo
Age: 66

Most hazardous	Less hazardous	Least hazardous
other fishermen	drought season	rainy season
chemicals	rivers	human population
crocodiles		catfish
		prosopis
		lungfish

Ranking	Most hazardous
1.	chemicals
2.	crocodiles
3.	other fishermen

Name (I9): Marco Limo
Age: 68

Most hazardous	Less hazardous	Least hazardous
other fishermen	rivers	prosopis
chemicals	human population	lungfish
crocodiles		rainy season
drought season		catfish

Ranking	Most hazardous
1.	chemicals
2.	crocodiles
3.	other fishermen
4.	drought season

Data analysis of card piling process (Figures 1a & 2a)

Name (I10): Christopher Kibawen
Age: 55

Most hazardous	Less hazardous	Least hazardous
drought season	catfish	rivers
crocodiles		rainy season
human population		prosopis
lungfish		
chemicals		
other fishermen		

Ranking	Most hazardous
1.	drought season
2.	crocodiles
3.	lungfish
4.	chemicals
5.	human population
6.	other fishermen

Name (I11): Jan Chebkokwa
Age: 52

Most hazardous	Less hazardous	Least hazardous
crocodiles	rivers	lungfish
chemicals	prosopis	catfish
other fishermen		rainy season
human population		
drought season		

Ranking	Most hazardous
1.	crocodiles
2.	drought season
3.	chemicals
4.	other fishermen
5.	human population

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