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Research Paper

Sustainable management of the natural vegetation cover and fish breeding grounds in the western shores of Lake Turkana

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ABSTRACT

The arid and semi-arid areas (ASAL) require enhanced management of the scarce environmental natural resources and this is well documented. This study shows that training through demonstration site creation enhances the management of the natural forest cover and fish breeding grounds. *Prosopis juliflora* had also been introduced to the area to mitigate the aridity and help in conservation of soil. However, *Prosopis juliflora* became an invasive weed, colonising most of the areas and thus, outcompeting indigenous tree species. The study areas were along the western shores of Lake Turkana and thus cover the impact of the invasive *P. juliflora* to the fisher folk community. Intervention techniques on invasive species management were introduced to the study area, as well as activities on sustainable management of the natural vegetation cover, and fish breeding grounds were carried out in consultation with two host community groups that had formed beach Management Units (BMU). The aim of the study was to demonstrate how sustainable management of the available forest cover in the area coupled with protection of fish breeding grounds was beneficial to ASAL communities. The communities were able to show attitude change and also realise income from an area that was previously filled with negative attitude towards the invasive prosopis.

Key words: *Prosopis juliflora*, fisherfolk, riparian vegetation, arid and semi arid areas, sustainable management.

INTRODUCTION

Sustainable environment and natural resource management is an important concept of poverty reduction in areas where agriculture and its related activities are the main sources of livelihoods (IFAD, 2012). Biological invasions pose one of the greatest threats to the world's biodiversity and are increasingly causing unwanted effects to economic and ecological systems in the world (Genovesi, 2009). The need to control or mitigate their effects is a major challenge to natural resource managers due to inadequate scientific knowledge, policies and resources (Wittmann et al., 2015). The report presented by IFAD (2012) indicates that rural poor people face a series of interconnected natural resource management challenges which increasingly degrade their ecosystem and biodiversity, thus resulting in declining forest resources as well as fish and marine resources, hence threatening their essential sources of income and nutrition. This situation is well versed in the arid and semi-arid lands of Kenya, particularly Turkana County where *Prosopis juliflora* has invaded riparian areas as well as lake shores, causing serious socio-economic impacts to communities living in the region (Maundu et al., 2009).

Turkana is a semi-arid area characterized by low and erratic rainfall and high temperatures ranging at 200 mm per annum and 30.5°C, respectively (Turkana County Government, 2015). Attempts to address the aridity in the area and shortage of fuel wood led to introduction of *P. juliflora* in 1980s by NORAD under Turkana rehabilitation project after encouragement by the national government and other forest agencies in 1970s and 1980s to plant

Prosopis in dry areas of Kenya (Mwangi and Swallow, 2005; Masakha and Wegulo, 2015). It was believed that the plant will provide outstanding solutions to Land use problems experienced in this areas such as improvement of soil characteristic through nitrogen fixation and control of soil erosion. The plant has proved adaptable to the environments where less or no other species can survive (Pasiecznik et al., 2001) and now aggressively colonising natural habitats (Mwangi and Swallow, 2005).

Prosopis invasion in areas has rendered many negative impacts both to the environment and the community (Shackleton et al., 2015) thus calling for prompt proper sustainable management mechanisms to address impacts of the invasion. According to Choge et al. (2007), the spread of *Prosopis* outside designated areas has adversely affected natural habitats, cultivated areas and rangelands, leading to loss of livelihoods particularly in pastoral areas. Kenya forestry research institute (KEFRI) has been mandated to conduct forestry research on forest and forest products and come up with Sustainable management of forest and its products. KEFRI has also played vital role in conducting end deliveries trainings after research to enable realisation of the *P. juliflora* as a resource instead of a menace. People's perception on the impact of invasive plants in their areas depends on how the plant solves the economic needs of the community (Pasiecznik et al., 2001; Swallow and Mwangi, 2008). The know-how by the community to utilise plants for economic purpose therefore may disregard the challenges attached to the invasions and instead uphold plantations. However, economic exploitation can be used to manage invasive tree species (Geesing et al., 2004) and this as elaborated in the other studies helps in managing invasive tree species through utilization strategy.

Ekoyo and Nareng'ewoi(Study areas) have not felt any interventional technique aimed at economic *Prosopis* resource use other than domestic uses such as source of fuel. Therefore, negative complaints on the invasiveness of the plant were sound in relation to positive complaints. The extend and severity of the complaints was determined by the weight of reliability of the people to the plant for livelihood source as compared with the negative impacts associated with its invasiveness. Alien plants have shown negative effects on biodiversity, agricultural production, livestock loss, fisheries and human health (Shackleton et al., 2015). These are the same complaints experienced in these study areas, magnified by the fact that the community lacks the basic information on utilization and processing technologies of the invasive Prosopis plant. In addition, there are no harnessed alternative management technologies employed to address the plant invasion. Therefore, the community is helplessly observing the plant naturalising in there agricultural lands, blocking the access routes to lake and in the process of fishing, tearing their fishing nets. The productivity of the community in the fishing sector and agriculture is alternately affected.

The long, powerful and poisonous thorns of the plant have also been reported to cause serious mechanical injuries to people and tooth decay for livestock browsing and feeding on the pod (Maundu et al., 2009; Haji and Mohammed, 2013); thus affecting their health which at the end leads to their death due to starvation. Biotic invasions and in this case *Prosopis* spp. invasion in areas bring serious problems which present extreme hazard to economic health of the natural resources based industries (Wittenberg and Cock, 2001). This with reference to the vibrant sector in the study areas has greatly affected the fishing sector. *Prosopis* invasion in the study areas have caused the loss of the indigenous forest and regeneration of pioneer *Acacia tortilis*, which for long has been the natural resource used for varied benefits ranging from domestic aspect of being sources of fuel wood and construction materials at homesteads to the medicinal and fodder for livestock (Muturi, 2012). Land as a resource and residential space for the people has been invaded by *Prosopis* making it inhabitable through the experienced dense invasions of *P. juliflora*. A lot effort is required to clear the invaded fields and uproot the root system of the plant to avoid sprouting on the need to create a residential space.

Under *Prosopis* canopy, less herbaceous plant or under growth is experienced (El-keblawy, 2012). This is supported by the allelopathy character of *Prosopis* spp. and on the study areas, originally known grasslands have also been colonised by the invasive plant. Reinstating relatively original environmental state with introduced *Prosopis* species in the study areas; this study addresses sustainable management of *P. juliflora* using utilization approach and management through Silvicultural and thinning practices and making the community count and own the adaptable measures decided. The community stands at the centre of the study plans so as to ensure the ownership and sustainability of the measures implemented. The aim of this study was to demonstrate how each BMU and their members have developed and committed to implement a compressive inclusive and long-term plan on sustainable NRM in the area under their responsibility. Similarly, the study aimed at showing how BMUs and their members have agreed upon effective measures to protect and sustainably manage the fish breeding grounds under their responsibility as well as describing the internal governance and performance of BMUs through clarification of mandate, roles and responsibilities; transparency in management and accountability towards members and other stakeholders.

METHODOLOGY

Study sites

The study sites are Nareng'ewoi (N $04^{0}00'07.5''$ E 035^{0} 51' 10.5) and Ekoyo (N $03^{0}35'02.3''$ E $035^{0}50'49.1''$) in Turkana County, Kenya. The study areas are situated at the

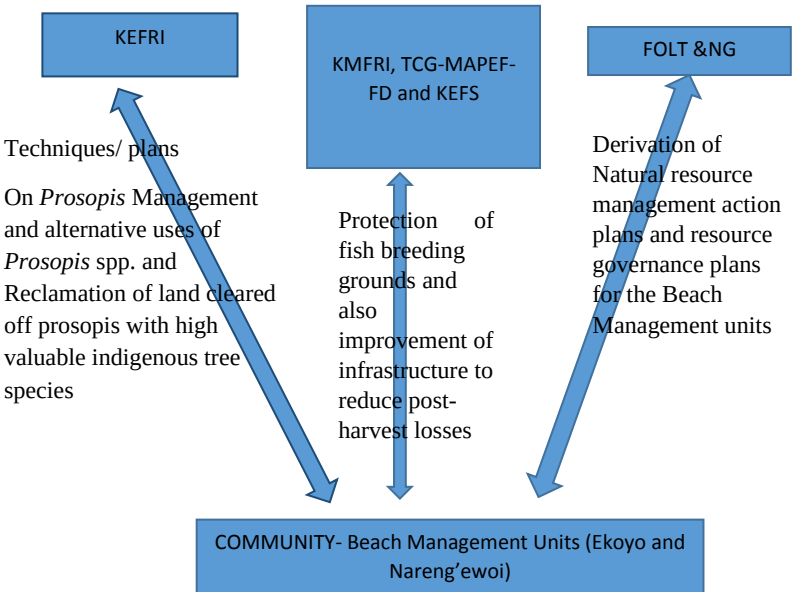

Figure 1: The three agencies engaged with the community on the interventions
Abbreviations:
KEFRI- Kenya Forestry Research Institute
KMFRI- Kenya Marine and Fisheries research Institute
TCG-MAPEF-FD- Turkana County Government- Ministry of Agriculture, Pastoral Economy and Fisheries
KEFS- Kenya Fisheries Service
FOLT- Friends of Lake Turkana
NG- National Government- Ministry of Interior-Chiefs.

western shores of Lake Turkana and are highly invaded by *P. juliflora.* The project work covered the month of August 2016 to February 2017.

P. juliflora has become invasive in most introduced arid areas of Kenya. Therefore, the concept of this study is drawn from a scenario of the study area being invaded and no *Prosopis* management intervention techniques have been employed. Notable current prevailing conditions and of the near future required transdisciplinary approach to manage invasive *Prosopis* and also utilise the fisheries resource in a sustainable manner while engaging with the governing of the natural resources management. At the centre of the measured development, the community stand at the midst and their approach counts. This is aimed at developing sustainable measures by the communities affected. The organisations acting are shown in Figure 1

Land preparation and planting

We started with clearing of 6 acres each in Ekoyo and Nareng'ewoi and then fencing two plots each of 3 acres in the cleared areas. Micro-catchments at spacing of 4 m by 4 m were constructed using cash-for –work approach and indigenous trees were planted. In Ekoyo, 156 micro-catchments were constructed each micro-catchment accommodating one seedling. In Nareng'ewoi, 166 micro-catchments were constructed each accommodating two seedlings, thus 332 seedlings planted. Two bags of *Cechrus ciliaris* seeds were broadcasted on a 3-acre land in each site. The growth of grass seeds were dependent on rainfall and were managed by community members.

Training of community members

With the aid of fisheries department experts, Fish breeding environmental management committees were also formed, trained and their roles defined. 80 community members from Ekoyo were trained on modern fish processing unit, component of the processing unit and how to use and maintain the installed structure. For Nareng'ewoi100 members were trained on silviculture and pasture production. Also, NRM plans for protection of fish breeding grounds were made in consultation with the community members. Two appropriate small fish processing units were set in each of the study areas and community was trained on the use and maintenance of the installed fish processing units. Training on improved fish process and techniques was also done by fisheries department. Civil society represented by Friends of Lake Turkana (FOLT) conducted community review of existing BMU regulations in the two sites and a hundred Community members were trained on governance and accountability in the two sites.

Figure 2: Community constructing micro-catchments in the area cleared off *Prosopis* (in the background) doing this by themselves after training was done.

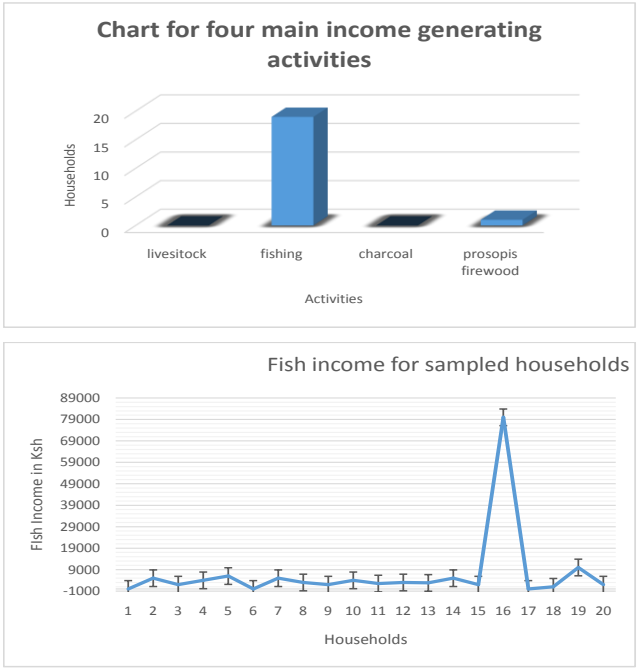

Figure 3: (a) Main sources of income for the households in the two beach management units in Ekoyo and Nareng'ewoi, (b) household income through sale of fish.

They were also aided in formation of Audit committees. The officials of the two-study site BMUs were trained on financial literacy, administrative management and participatory Monitoring and evaluation.

Survey

A baseline survey together with an end of project survey was carried out in a random manner to the household heads in each of the project sites. The Total number of Beach Management Units (BMU) members was taken and using a formula to represent 20% of each BMU, a sample size was derived. Following which members were assigned numbers, randomly 20 numbers were used to draw out the persons to be interviewed, with key informants and stakeholders used in verification of these survey results (Figure 2).

RESULTS

The results of the study as shown in Figure 1 was realised through various trainings and forums conducted on the aimed techniques and approaches to enable management of the natural forest and fish breeding grounds in the western shores of lake Turkana (Figures 3 to 5). Evaluation on the

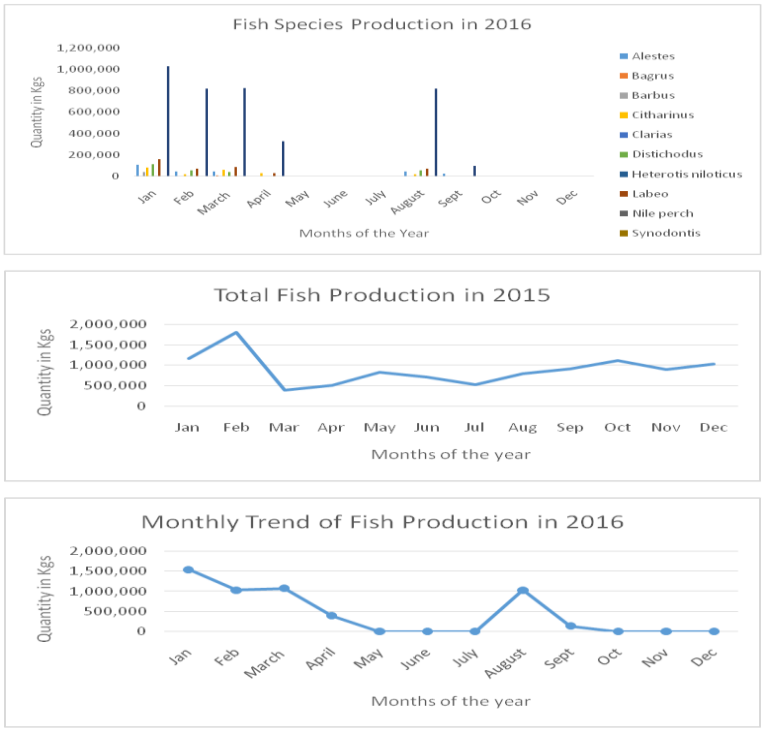

Figure 4:(a) Monthly fish yield before the project intervention and post project intervention, also showing the fish species produced from the two BMUs in Lake Turkana in the year 2016. Fish harvesting was restricted in the month of May, June, July, October, November and December; hence no data was recorded. (b) show the monthly trend of fish production from Lake Turkana in 2015 (before project intervention and 2016 (c) after project intervention.

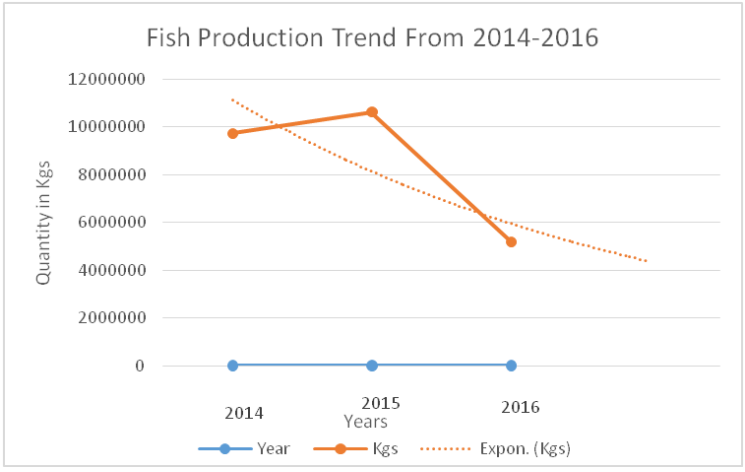

Figure 5: The annual trend of fish production in Lake Turkana from the year 2014-2016.

adoption of the techniques is later done through questionnaire assessment on the change. Fishing stands out as the main economic activity in the area while livestock and charcoal are the least activities undertaken by the communities.

Improvement of post-harvest fish

Ekoyo and Nareng'ewoi communities were provided with modern preservation facilities (solar driers) to reduce post-harvest fish losses. The solar driers were constructed at

Figure 6: Solar driers installed using locally available materials and also community recommended sites near the beach.

homesteads where community members can have assess conveniently to dry their fish efficiently (Figure 6).

DISCUSSION

Even though fishing is the major source of livelihood for the fisher folk communities in Turkana, Lake Turkana is no longer dependable for fish production. This was confirmed by the response made by interviewed community members on the dependability of the lake and the income per month received by interviewed community members on the major source of livelihood. This was also confirmed by the questionnaire that by statistics more than 50% of the interviewed community members were not comfortable with their current living standard. The limited source of livelihood activities ventured in by people in the lake region and non-realisation of the utilization strategy of some available resources continues to make the communities more vulnerable to food and nutrition insecurity.

The efficiency, effectiveness and performance of solar driers for drying fish have been demonstrated in Nigeria (Mustapha et al., 2014), Ethiopia (Zebib et al., 2017) and Bangladesh (Rahman et al., 2012). Based on these studies, the use of solar driers technologies for drying fish has yielded positive results and has helped in improving post-harvest fish losses. Similarly, solar tent driers has successfully been used in Malawi to reduce the time needed to dry fish while protecting the fish from contaminants such as dust and flies (Njuki, 2017). The use of solar driers will aid immensely Lake Turkana communities in preserving fish in hygienic conditions and improving their income level.

P. juliflora, which is an available resource in Ekoyo and Nareng'ewoi is underutilised by the community. In this regard, KEFRI technologies for sustainable charcoal production and silvicultural practices such as pruning and thinning of *Prosopis* have enabled the communities to realise the economic value of *Prosopis* plant and management strategies to enable ample plant diversity in the environment. Alternatively, the plant has also been used in the core livelihood activity in these areas in constructing solar driers for fish processing to reduce post-harvest loss of fish.

CONCLUSION

Currently, economic mind has intervened whereby woodland resources are used for entrepreneurial benefit. Modern charcoal production, practice of apiculture and derivation of desired poles for construction are the adopted alternatives by the community to enhance livelihood standard. Moreover, sustainable *Prosopis* management and reintroduction of the indigenous species have been adopted communally and individually in the two communities whereby reforestation farm is managed by the community and individual people have taken the initiative of planting the indigenous trees in their homesteads.

In regards to the challenges which the communities had experienced with Prosopis invasion in the past (as listed below), most of them have been addressed and the community appreciate *Prosopis* forest cover.

- The loss of indigenous trees species
- Lack of underground growth in invaded prosopis areas
- Mechanical injuries
- Animal death

Economic utilization of Prosopis plant has proven sustainable in managing *Prosopis* cover and the communities have taken up the initiative to conserve indigenous trees while using *Prosopis* to earn income.

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