

See discussions, stats, and author profiles for this publication at: <https://www.researchgate.net/publication/337022129>

Factors influencing capacity of beach management units in implementing fisheries co-management in a tropical desert lake

Article · November 2019

CITATIONS

0

READS

197

5 authors, including:



Maurice Ogoma

Egerton University

6 PUBLICATIONS 4 CITATIONS

SEE PROFILE



Bernard Kirui

Egerton University

17 PUBLICATIONS 46 CITATIONS

SEE PROFILE



Obwoyere .O. G.

Egerton University

32 PUBLICATIONS 63 CITATIONS

SEE PROFILE



Evans Obura

Egerton University

5 PUBLICATIONS 94 CITATIONS

SEE PROFILE

Some of the authors of this publication are also working on these related projects:



Conservation of Terminalia Brownii in the Drylands of Kenya [View project](#)



Forest Ecosystem Health and Anthropogenic Disturbance in South Western Mau Forest Resrve Kenya [View project](#)

Factors influencing capacity of beach management units in implementing fisheries co-management in a tropical desert lake

Maurice O. Ogoma^{1}, Bernard K. Kirui¹, Gilbert O. Obwoyere¹, Evans O. Obura² & Elick O. Otachi²*

¹Department of Natural Resources, Faculty of Environment and Resources Development, Egerton University, P.O. Box 536-20115 Egerton, Kenya

²Department of Biological Sciences, Faculty of Science, Egerton University, P.O. Box 536-20115 Egerton, Kenya

*Corresponding author: luleogoma@gmail.com

Factors influencing capacity of beach management units in implementing fisheries co-management approach in a tropical desert lake

Abstract

Lake Turkana fishery consists of seven endemic and 12 commercially exploited species and is the second largest producer of freshwater fish in Kenya. It supports livelihoods of approx. 300,000 people locally. The lake is managed by beach management units (BMU) through a co-management arrangement between the government and stakeholders. Despite this, it faces management related challenges that have resulted in plummeting fish production due to uncontrolled fishing effort, increased competition among fishermen and deficient statistics to support management objectives. This study investigated institutional factors influencing BMUs' performance by examining training and level of understanding of BMU laws and regulations, funding sources and usage and equipment ownership. A cross-sectional study was adopted and purposive sampling used to collect data from 693 respondents using questionnaires. Chi square was used to test for statistical differences at 95% significant level using MINITAB statistical software. Results showed that resource mobilization was statistically significant ($\chi^2=154.098$, $df=21$, $p=0.00$) but donors (45%) contributed most funds compared to national government (21%), county government (19%) and well wishers (15%). Main revenue sources were membership registration (41%) and daily landing fees (25%). Revenue was used to purchase fishing gears (47%), supported welfare activities (18%) while significant portion (35%) was shared by members. Members' training was statistically significant ($\chi^2=79.510$, $df=14$, $p=0.000$) but only 35% were effectively trained while 65% had contrary opinion. Members were trained on fish handling (49%), BMU laws (28%) and micro-credit (23%) but key training gaps included data collection, conflicts resolution and sea surveillance/patrols. BMUs owned equipment; however, 87% were poorly serviced while others were not available. BMU performance could be improved mainly by providing financial support (27%), capacity building (19%) and security to fishermen (17%). This study identified critical capacity factors influencing BMU operations. The factors should be enhanced by various stakeholders to support BMU performance and promote collaborative management of fisheries resources in Lake Turkana.

Key words: Lake Turkana, beach management units (BMU), Co-management, Fisheries, Capacity, Training, Equipment, Funding

1. Introduction

Co-management is a system whereby responsibility for management is shared between the government and resource users, usually at the local level. It is a hybrid governance regime combining centralized and decentralized, state and community institutions (Singleton, 2000). The need for co-management intensified at the global scale in the 1990s and many countries attempted to establish local or regional co-management systems. Since it strengthens the influence of local resource users, co-management has proved to be multi-functional, making it instrumental for the solution of different problems (Linke and Bruckmeier, 2015). The approach is guided by many principles including collaboration and shared responsibility between resource users and managers, participation and empowerment of stakeholders, institutional embedding and decentralization of decision making, justice and equity with regard to sharing of resources (Linke and Bruckmeier, 2015). Co-management is promoted for managing natural resources including fisheries, forests, wildlife and water. In fisheries, it has been applied in management of complex social-ecological systems particularly small-scale fisheries (Gutierrez *et al.*, 2011; Quimby and Levine, 2018).

In East Africa, the approach was first initiated in Lake Victoria during the first phase of the Lake Victoria Environmental Management Project (LVEMP) (AU-IBAR, 2018). The adoption of fisheries co-management in East Africa followed similar initiatives in other parts of the world, which responded to concerns of fishing illegalities and inadequate capacity within the fisheries departments to effectively manage the lake fisheries (Nunan *et al.*, 2015). The outcome of fisheries co-management with regard to compliance with laws and regulations and improvement of fish stocks has been varied in East Africa (Kanyange *et al.*, 2014; Onyango and Jentoft, 2007) partly because co-management arrangements are anchored on short term projects with inadequate support by the government (Nunan *et al.*, 2015). Even in areas where success in fisheries co-management has been realized like improved registration of fishermen and boats, improved licensing and involvement of fisheries stakeholders in management (Onyango, 2014), high level of fishing capacity, increased fishing illegalities and reduction of fish stocks have been common (Mkumbo and Marshall, 2014). This has meant that various actors should be brought together in a formal arrangement to help generate solutions that can counter these challenges.

Co-management actors are brought together in a formal organization representing resource-users with management support provided by the government. In Kenya, this organization is referred to as beach management unit (BMU) whose membership is drawn from local stakeholders including among others fishermen, fish traders, boat owners, fish processors, equipment dealers and repairers. The administrative structure of BMUs consist of an assembly that includes executive committee and all registered members who are engaged in fisheries activities at beach level; an executive committee; and at least three sub-committees responsible for patrols/fisheries management, financial management and protection of the environment (GoK, 2016). BMUs are mandated to strengthen governance by attaining a more appropriate, efficient, and equitable fisheries resource management. Currently, marine and inland capture fisheries are co-managed in

Kenya by BMUs and the government. Since BMUs act locally, they need appropriate capacity in order to effectively manage the fisheries. They should mobilize resources to acquire the right equipment and other resources for their day-to-day operations while their capacity need to be build in order to not only understand the legal framework within which they operate, reduce illegal fishing activities and acquire appropriate skills to reduce fishing effort, but also to increase fisheries production to sustain livelihoods while conserving the resources. According to Tweddle *et al.* (2015), African lakes face many challenges related to management capacity and anthropogenic factors. In Lake Turkana, for example, these challenges include among others illegal, unreported and unregulated (IUU) fisheries, poor fish processing and storage and resource-use conflicts (GoK, 2014), which have resulted in falling fisheries production in the lake negatively impacting on livelihoods of local inhabitants. These could be the result of inadequate management capacity in relation to funding, training, instrumentation and the degree of understanding of the BMU mandate. The aim of this study was to investigate the capacity of BMUs to implement fisheries co-management approach in Lake Turkana in relation to funding, training, equipment availability and the level of understanding of fisheries and BMU laws and regulations.

2. Materials and Methods

2.1 Description of study site

Lake Turkana, the World's largest desert lake, is located at the north of the eastern Rift Valley at an altitude of 375 m above sea level and extends from 35°50' to 36°40' E and 2°27' to 4°40' N (KMFRI/LTRP, 2007). It is the deepest water mass in Kenya and covers an area of 7560km² (Campbell *et al.*, 2003). The lake is a designated United Nations Educational, Scientific and Cultural Organization (UNESCO) World Heritage site owing to its role in supporting local fishery livelihoods and biodiversity. About 300,000 people, majority of whom are extremely poor, heavily rely upon the lake's resources either directly or indirectly to support their fishery and related livelihoods (ILEC, 2013; Odada *et al.*, 2003). This has led to diminishing resources in the lake's region which has resulted into violent conflicts between local communities and tribesmen from Sudan and Ethiopia (Hathaway, 2010). The area around the lake has no significant industrial activities owing to its arid nature with slightly saline water (Otachi *et al.*, 2014). The only known pollution problem in Lake Turkana is that of suspended solids (Odada *et al.*, 2003) coming from the drainage basin of Omo River in Ethiopia (Otachi *et al.*, 2014) and sedimentation from soil erosion as a result of removal of vegetation cover for fuel and conversion of forest land into agricultural fields (Haack and Messina, 2001).

2.2 Research design and data collection

A cross-sectional research design was adopted in this study with the subject of interest being fisheries co-management. All respondents were assumed to be aware of BMU operations and their performance. Purposive sampling was used to identify eight BMUs spread from south to north Lake Turkana. The basis for identifying BMUs was the period of existence for at least 5 years since this period of BMU operation would be adequate time for the BMUs to have generated adequate evaluations for co-management execution and results. Data were collected using questionnaires with both closed and semi-

structured questions. Questionnaires were chosen following Luomba, (2013) since they generate large amounts of data quickly, facilitate cooperation between respondent and interviewer, and make it easy for immediate follow-up for omission that may occur during interviews. Cochran's formula (Cochran, 1997) was used at 95% confidence level and a 5% margin of error to determine the sample size allocated for each BMU. However, following Bartlett *et al.* (2001), we modified the formula due to the small population size of the BMU members and calculated the final sample size allocated to each BMU. Out of the total 2245 BMU members in the eight study BMUs, 693 respondents were calculated for questionnaire administration (Table 1).

Table 1: BMU population and sample size calculated for each BMU

BMU	Total	% Men	% Women	Sample size
Natirae	202	76	24	82
Impressa	234	55	45	87
Nariemet	102	68	32	59
Lomekwi	144	59	41	71
Eliye	226	73	27	86
Kerio	669	67	33	115
Todonyang	412	39	61	103
Lowerangak	256	42	58	90
TOTAL	2245	58	42	693

The respondents who included male and female BMU members aged at least 18 years were selected through systematic sampling with every third individual in the official BMU register randomly picked for questionnaire interviews. For each BMU, two respondents were each included from the following categories: BMU executive officials, knowledgeable fishers from the community identified by the fisheries officers, local elders defined as those aged 60 years and above, fisheries officers, and institutional stakeholders from the non-governmental organizations (NGO).

2.3 Data analysis

Questionnaire data were summarized in MS Excel upon which frequencies were generated. The frequencies were subjected to chi-square test ($p < 0.05$) in MINITAB statistical software version 14. The chi-square was used to test for statistical differences between the expected and observed frequencies on levels of training among BMUs, level of understanding of laws and regulations, sources of funding and revenue use. Other quantitative data were analyzed using descriptive statistics and presented in percentages, tables and charts.

3. Results

3.1 Resource mobilization

Resource mobilization from external sources was statistically significant ($\chi^2=154.098$, $df=21$, $p=0.00$), however, donor funding including direct donations and proposals development was the greatest source of funding accounting for 45%. National and County government contributed 21% and 19% respectively while well wishers, mainly from donations by politicians and *harambee* (fundraising) accounted for 15% (Figure 1). Donor funding was highest in Kerio, Lowarangak and Nariemet where there were ongoing NGO-funded programmes. National government contributed more funding in Todonyang, Kerio and Lowarangak while respondents mentioned high support by County government in Natirae, Eliye and Impressa BMUs.

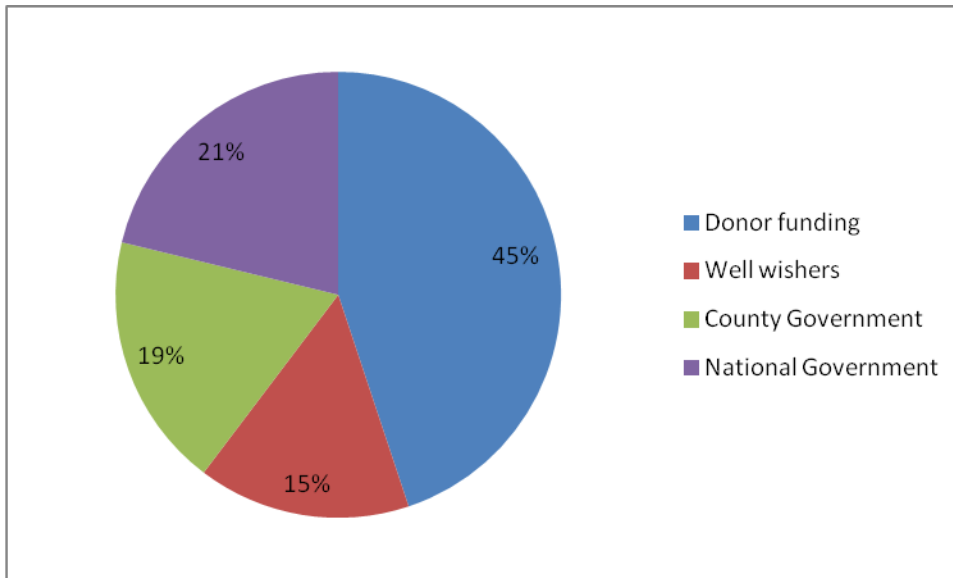


Figure 1: Respondents' opinion on sources of external funding (%) to BMUs

Respondents reported four sources of internally generated revenue which were statistically significant ($\chi^2=209.713$, $df=21$, $p=0.000$), however, membership registration (41%) and daily landing fees (25%) were the most common. Levies from fines (18%) and business income (17%) generated through ecotourism activities and storage fees were less common. Among individual BMUs, membership registration was the leading source of revenue at Lowarangak and Kerio while daily landing fees was highest in Natirae and Impressa. Levies from fines charged on offenders were mainly generated at Lomekwi and Natirae while income from BMU business was common in Nariemet and Eliye. Table 2 shows percent variation in funding from external sources and internally generated revenue among the study BMUs of Lake Turkana. Most of revenue generated by BMUs was used to purchase fishing gears (47%) while 18% supported welfare activities.

Table 2: Percent variation in funding from external sources and internally generated revenue among the study BMUs of Lake Turkana

	Natirae	Impressa	Nariemet	Lomekwi	Eliye	Kerio	Todonyang	Lowarangak
<i>Source of external funds</i>								
Donor funding	28	40	68	25	40	62	34	61
Well wishers	10	11	10	44	16	12	16	9
County Government	39	28	14	13	30	10	8	11
National Government	23	21	8	18	14	17	43	19
<i>Internal revenue sources</i>								
Fines	24	15	15	51	17	10	10	12
Membership	18	33	25	17	31	60	54	64
Landing fees	45	41	14	23	15	19	28	11
Business	12	10	46	10	36	10	8	12

However, a significant portion of collected revenue (35%) was shared among BMU officials and members (Figure 2).

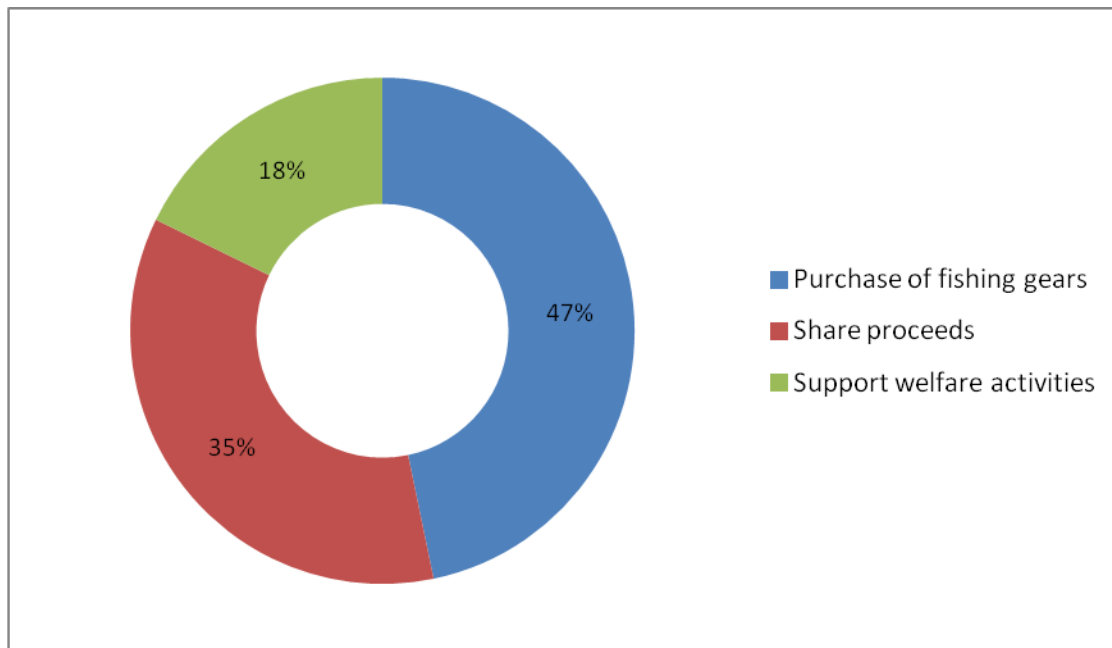


Figure 2: Ways of revenue utilization among BMUs of Lake Turkana

3.2 Training and skills development

There was significant variation on skills development of BMU members who have been trained and those who have not received training ($\chi^2=79.510$, $df=14$, $p=0.000$). Majority of members (66%) were not trained while 34% reported to have received training.

Members received trainings on fish handling (49%), BMU laws and regulations (28%) and micro-credit (23%) (Figure 3). Five areas of training gaps were reported by respondents. The training gaps were statistically significant ($\chi^2=212.784$, $df=35$, $p=0.000$) and included trainings on fisheries data collection (26%), conflicts resolution (24%) and lake patrols, monitoring and surveillance (23%). Other training gaps included fisheries and BMU rules and regulations (16%) and financial management.

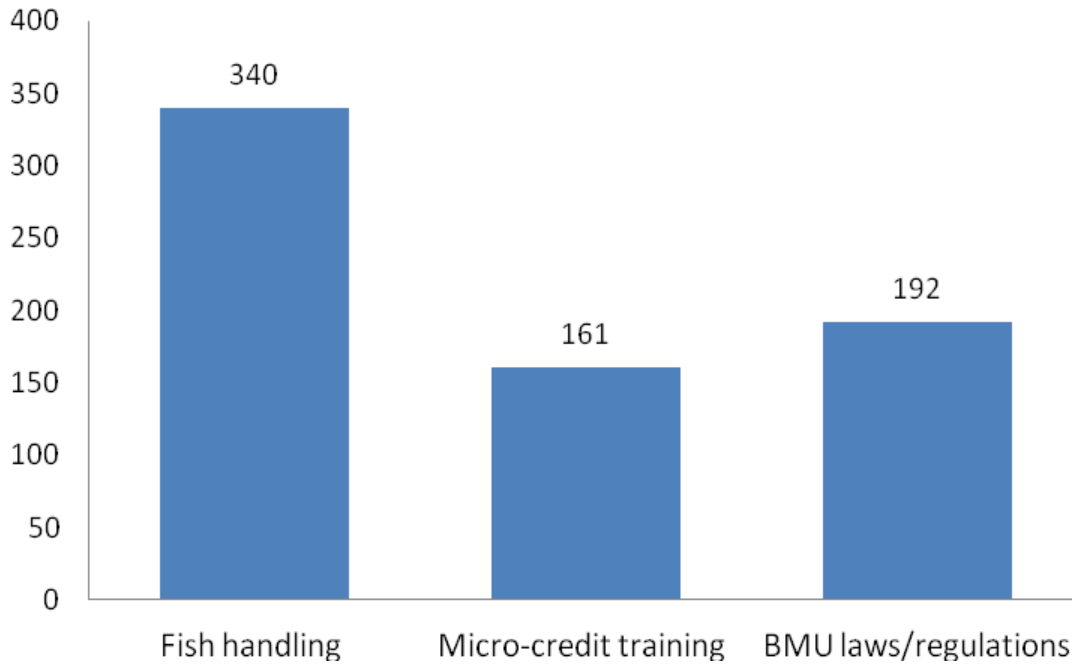


Figure 3: Respondents’ opinion on the types of trainings received by BMU members in Lake Turkana

However, there were variations on training gaps recorded by each BMU. Need for training on data collection was significantly mentioned by Impressa, Natirae and Eliye, conflicts resolution was high in Kerio and Todonyang while lake patrols, monitoring and surveillance was mentioned highly in Lowarangak, Todonyang and Lomekwi. Training on BMU and fisheries laws and regulations was reported in Eliye and Impressa while trainings in financial management were reported in Nariemet and Natirae (Figure 4).

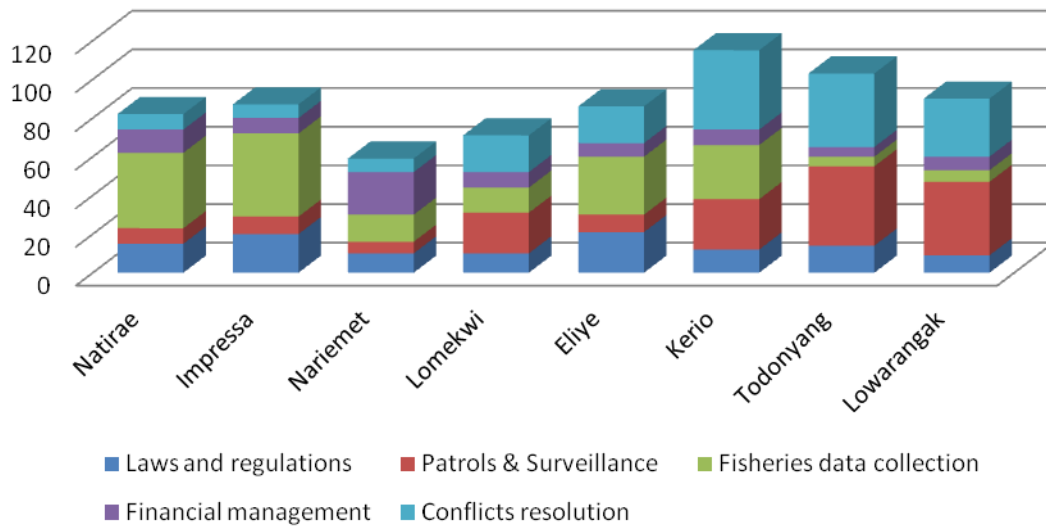


Figure 4: Respondents' opinion on training gaps in BMUs of Lake Turkana

3.3 Equipment

Six types of equipment were owned by BMUs. These included office furniture, computer, fishing boats, weighing scales, fishing nets and patrol boat. Computer was the most common equipment owned by all the BMUs except Lomekwi. Four BMUs (Natirae, Impressa, Kerio and Lowarangak) owned fishing boats, weighing scale and fishing nets while Natirae and Nariemet owned office furniture. None of the BMUs owned patrol boats except Natirae. However many equipment that are important for fishing operations were missing in all the BMUs. These included first aid kits, motorized fishing boats, sun-glasses/dive shades weighing scales and life jackets.

3.4 Understanding of rules and regulations

Although 34% of BMU members had been trained, there was variation in understanding of BMU rules and regulations among the BMU members ($\chi^2=134.840$, $df=35$, $p=0.000$). Respondents reported low understanding (37%) followed by medium (23%), lowest and high (each 16%) while 8% had highest understanding (Figure 5).

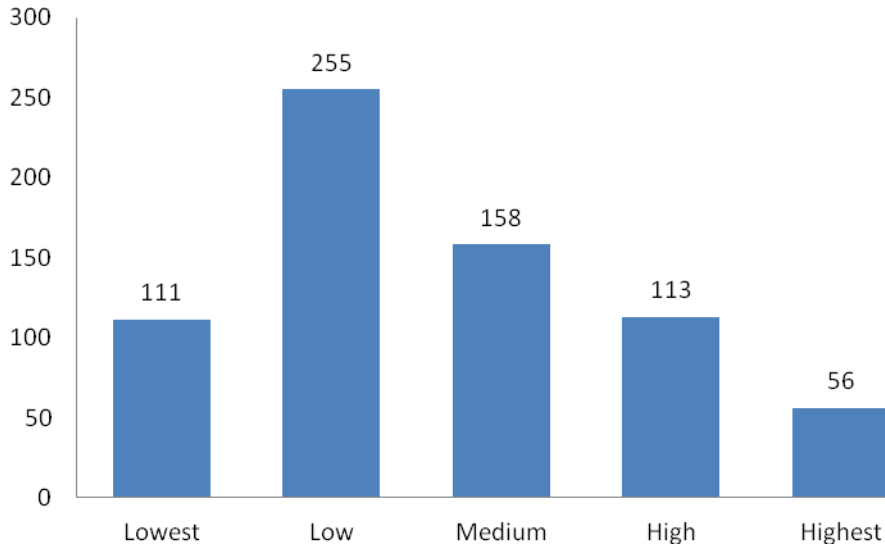


Figure 5: Respondents' opinion on the level of variation on understanding of BMU laws and regulations in Lake Turkana

Among respective BMUs, Todonyang (n=35) reported lowest understanding of rules and regulations, low understanding was reported in Kerio (n=74), medium understanding in Lowarangak (n=30) while high understanding was reported in Impressa (n=33). However, less than ten respondents reported highest understanding in all of the study BMUs (Figure 6).

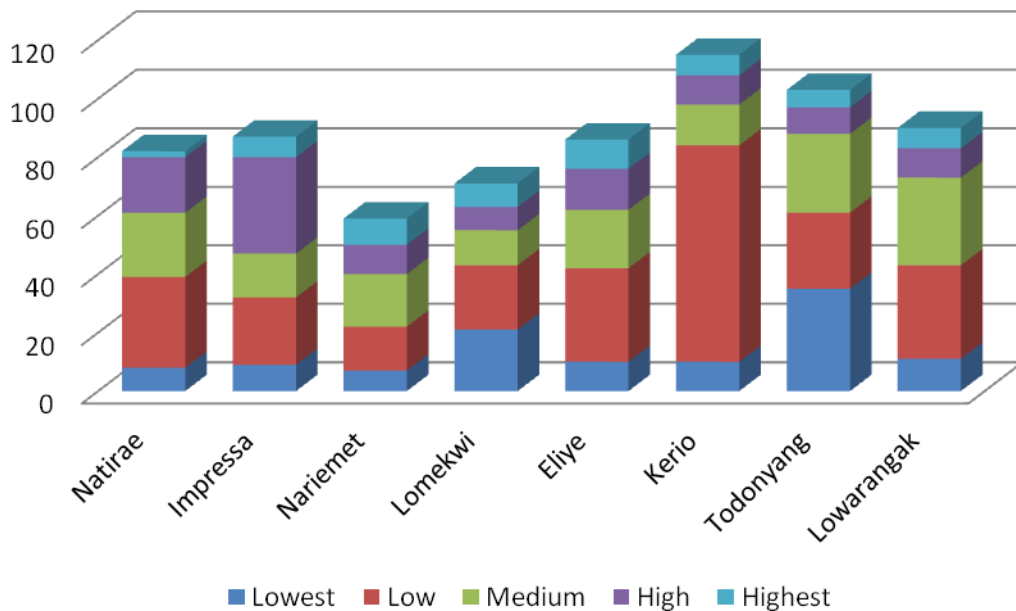


Figure 6: Respondents' opinion on the extent of members' understanding of BMU laws and regulations in Lake Turkana

4. Discussion

4.1 Resource mobilization

With 45% of resources mobilized from and supported by donors, our results are a clear indication of the overdependence of BMUs on external support for co-management activities mainly by donor agencies, development partners and international NGOs. The support come in various forms including initiation of development projects that support various activities such as trainings and capacity building of BMU officials and members, provision of fishing gears and equipment and development of physical infrastructure such as offices and fish processing and storage facilities. Although national government support comes second at 21% as perceived by the respondents, this perception may be inadequate considering the overall role of government in development and implementation of co-management policy, infrastructure development including human resource, fish markets and regulation of fishing activities. These supportive resources may go unnoticed by just considering people's perceptions since such resources are hardly quantified or valued by the public yet they contribute to the success of co-management.

Respondents from northern Lake Turkana BMUs which are closer to Ethiopia (such as Lowarangak, Todonyang and Lomekwi) indicated that national government support was provided in form of security. However, BMUs to the south of the Lake (such as Eliye, Kerio, and Nariemet) indicated that the government provided support in form of infrastructure and personnel to monitor fisheries activities, signifying a variation in perception based on what the respondents deemed important for them and their areas of operation. For example, it was obvious for the northern BMUs to emphasize on security due to violent conflicts that occasionally erupt between Kenyan local communities and Merile community from Ethiopia. Although there is a new decentralized system recognizing counties as the local administrative units, the Turkana County government funding to BMUs was perceived to be limited (19%) indicating that their impact has not been felt fully by local institutions like BMUs. The support they provide such as provision of equipment could be linked to activities of donor organizations while such activities like development of fish markets and charging levies on fish trade could be linked with the work of national government showing overlap of duties and responsibilities of stakeholders. This argument is supported by the results of Haambiya *et al.* (2015) who suggested that fisheries stakeholders should have distinct responsibilities so that their impact can be felt locally.

Although BMUs raised revenue internally using four methods, membership contribution and collection of daily landing fees which accounted for 41% and 25% respectively were not adequate to support BMU activities. Membership contribution for example is a one-off exercise at the time of an individual member joining the BMU while BMU members fail to comply with payment of daily landing fees due to weak mechanisms to ensure enforcement of BMU by-laws. Other methods such as fines and businesses were not well explored hence contribute the least revenue. Enforcement for payment of fines for failure to comply with by-laws was difficult due to family ties between offenders and BMU officials and lack of capacity to enforce payments. Revenue from BMU businesses like

ecotourism initiatives and storage fees was minimal indicating lack of diversity in income generating activities and lack of storage facilities owned by BMUs. However, income from ecotourism was high in Eliye since the area is an ecotourism site as a result of Eliye Springs where private ecotourism operators would pay fees to the BMU as part of co-management arrangement. Storage levies was also charged at some BMUs like Nariemet since the BMU has large fish storage facilities provided as a grant by the donor community. There is high potential to develop such initiatives to enhance income generation among BMUs and reduce their dependence on external support.

Revenue generated was used to purchase fishing gears although this could lead to increased fishing effort that would put more pressure on the lake's resources. Considering that 35% of revenue collected is shared among BMU officials and members there is likelihood that this would impact negatively on the sustainability of BMU operations since such revenue may not be equitably shared among the BMU membership. As reported elsewhere (see e.g. Luomba, 2013; Obiero *et al.*, 2015; Pathmanandakumar, 2017), BMUs need adequate capacity including financial support to meet most of their management and administrative objectives. However, the revenue generated should be allocated to perform the right BMU activities to avoid corruption and related illegalities that have bedeviled many BMUs across East Africa (Nunan *et al.*, 2018).

4.2 Training

There was divergence in training of BMU members and officials, indicating that the two groups have different training needs. Although many members confirmed that they have been trained, a good percentage (49%) proved that either they have received no training or are not aware of any trainings. This shows that the trainings could be selective with many members not informed or the duration of trainings could be very short and easily forgotten by the trainees. The inability of some respondents to specify the specific training areas and some BMU officials who are not aware of the trainings received also confirm this. The variation in training gaps reported by respondents indicates that both members and officials are not well trained in crucial areas that would strengthen their capacity. For example, BMU officials have no or little trainings on fisheries data collection, fisheries and BMU laws and regulations, financial management, BMU management and lake patrols, which are all their mandate to effectively implement fisheries co-management. Members also lack trainings on areas that would strengthen their capacity in their day-to-day activities and contribute to their livelihoods such as fish marketing, fish preservation and sustainable fishing. Besides, trainings were not uniform among BMUs. In Nariemet for example, members were trained on micro-credit and leadership but such trainings are conducted only with support from donors. In most cases such trainings are one-off with limited follow-ups hence creating continuous capacity gaps in BMUs and limiting sustainable fisheries management. The role of training in strengthening BMU operations, sensitization and skills development is critical in promoting sustainable utilization of fisheries resources. These findings are consistent with Try and Sitha (2011) who emphasized training as a key methodology for promoting community fisheries through building awareness and dissemination of fisheries law,

skills on financial management, administration, patrols, community fisheries management, and fisheries conservation.

4.3 Equipment

Although many equipment were available in BMUs there is inadequacy in the operations of various instruments. For example, it was observed that computers are not put into use while furniture are poorly maintained in some BMUs like Natirae and Impressa except in Nariemet and Lowarangak where computers are in use and furniture well maintained due to ongoing grants funded by donors. Respondents reported that weighing scales are not owned by the BMUs nor are they used to weigh fish at the beaches but are property of fish dealers who use them when buying fish but no records are maintained on daily sales by the BMUs. Availability of fishing boats and nets would mean higher fish production due to increased effort but this is not the case for Lake Turkana since the condition of some boats are not disclosed while the availability of most nets are not traceable with no available records. This could be an indication of inactivity in some BMU offices or lack of adequate training to use some equipment implying misuse of donated equipment and potential conflicts arising from their use. Since there is no inventory for use of equipment it is difficult to establish any order of equipment use indicating potential misuse and poor maintenance. Only one BMU (Natirae) has patrol boat indicating the other BMUs do not have the capacity to conduct rapid patrols in the lake to monitor fishing operations or conduct rescue operations in case of emergency. BMUs do not have other important equipment such as life jackets, sun-glasses/diving shades and first aid kits that would be important for supporting monitoring, data collection and safety operations and response in the lake. However, conducting monitoring, control and surveillance (MCS) operations would require adequate financial resources for administration and equipment maintenance yet there is no stable financial mechanism in the BMUs except donor support. This observation is consistent with Obiero *et al.* (2015) who concluded that BMUs fail to comply with fisheries rules and regulations due to inadequate financial resources and equipment to conduct monitoring, control and surveillance (MCS) operations resulting in failure to control illegal fishing in their areas of operation.

4.4 Understanding of laws and regulations

There was variation on reporting of BMU members understanding of BMU laws and regulations between the BMU officials who reported medium understanding and the BMU members who reported high understanding. This variation could have resulted from the BMU officials giving opinion on all the BMU laws and regulations and the general non-compliance by the BMU members while BMU members could have focused their responses on the most common rules in the by-laws. The high and medium understanding as reported by the members and officials respectively could be as a result of many factors. These include the availability of BMU by-laws in all the BMUs, attendance of BMU sensitization meetings and seminars whereby members are taught on their roles and responsibilities hence building their capacity. The most common by-laws reported by the respondents were: BMU members must have licenses to operate as fishermen or fish traders/dealers, fishing is prohibited in fishing areas, cleaning of the beach after work, illegal fishing nets are prohibited, no sale of fish to members of another BMU, and no

landing on beaches for non-registered boats but if allowed a landing fee or fine is paid. Even though these by-laws are available and well recognized by the BMU members, respondents reiterated that there was poor enforcement of these by-laws by the BMU officials indicating the willingness of members to abide by the laws and regulations if that would contribute to enhancement of the fishery of Lake Turkana. This is consistent with the findings of Luomba (2013) who concluded that BMUs have formulated regulatory measures to manage their fishery but have been ineffective in implementing some of the measures.

Despite the general understanding of the BMU laws and regulations as stipulated in GoK (2016), only selected few members were invited for sensitization meetings while no trainings were conducted at the beach where most fishermen are based. This signifies lack of openness in the way BMU officials conduct their activities. Poor schooling and a general lack of education among BMU members could hinder the understanding of most rules and regulations indicating the need for tailor-made training sessions for specific BMU membership groups such as fishermen, fish traders, boat owners and repairers. The results show that BMU members were aware of the importance of formulating by-laws mainly for fighting illegal fishing and fishing conflicts indicating that the right regulations have been formulated but compliance and enforcement could be the key challenges due to lack of enforcement capacity by BMU leaders. It could also be an indication that illegal fishing has been the most common illegal activity being practiced by fishermen while conflicts is an important aspect that the BMU leadership has to encounter in fisheries operations. The lack of enforcement capacity could be the result of poor leadership, corruption and cultural ties with offenders. Little emphasis is given to biological aspects of the fishery for protection of breeding grounds and probably no or very few by-laws, if any, have been formulated for the same. Capacity building of the BMU leadership and membership on the biological or ecological aspects of the fishery, and a review of BMU by-laws to incorporate the biology and environmental requirements of the fishery are critical for Lake Turkana's fishery.

5. Conclusions and Recommendations

There is overdependence on donor support by BMUs for capacity building, provision of equipment and projects development. The revenue generated internally by BMUs are limited and are not ploughed back to support co-management activities hence impacting negatively on sustainability of management. BMU members and their officials are partially trained on areas that would support fisheries co-management such as fisheries data collection, fisheries and BMU law and regulations, monitoring, control and surveillance (MCS), conflicts resolution and financial management among others. The trainings provided are not all-inclusive and are purely dependent on donors or government support without internally initiated programmes. This negatively impacts on the skills and knowledge of BMUs hence reducing their capacity to implement co-management initiatives. Equipment are mainly provided by donors to support BMU operations but most of them are not put in good use, poorly maintained and rarely serviced rendering them less supportive of co-management operations. Other equipment that would support MCS operations and rescue services during emergencies such as

patrol boats, life jackets and first aid kits are largely lacking hence reducing BMU capacities. BMUs have moderate understanding of fisheries and BMU laws and regulations despite trainings provided. This could be attributed to poor or no formal education of most members and inadequate policy implementation support by government agencies. To enhance capacity of BMUs in implementing the fisheries co-management approach in Lake Turkana, this study recommends the following strategies:

- a) Build capacity of BMU executives on resource mobilization to initiate income generating activities (IGAs) including ecotourism to increase revenue base of BMUs
- b) Enhance training of members on fisheries data collection, fisheries and BMU laws and regulations, financial management, monitoring, control and surveillance (MCS)
- c) Establish inventory of BMU equipment for ease of management and regularly service the available equipment

Acknowledgements

Resources for undertaking this project were provided by Egerton University including two members of staff for project supervision. We are grateful to the SDF&BE, KMFRI and Turkana County government who provided technical advise on sites access and gave initial critical information about the Lake's BMUs for logistics arrangements. We also thank the BMU officials and members who provided valuable information as respondents during the study. Finally, the permission to conduct the study was sought from National Council for Science, Technology and Innovation (NACOSTI) who provided research permit.

References

- AU-IBAR, 2018. Policy Brief: Comanagement Practices in Small-scale Fisheries: the case of Beach Management Units (BMUs) in Eastern Africa.
- Bartlett, J. E., Kotrlik, J.W. and Higgins, C.C. (2001). "Organizational Research: Determining Appropriate sample Size in Survey Research". *Information Technology, Learning, and Performance Journal*, 19(1), 43-50.
- Campbell, L. M., Osano, O., Hecky, R. E. and Dixon, D. G. (2003). Mercury in fish from three Rift Valley lakes (Turkana, Naivasha and Baringo), Kenya, East Africa. *Environmental Pollution* 125: 281-286.
- Cochran, W.G. (1977). *Sampling Techniques*. (3rd.). New York. Wiley.
- GoK. (2016). *Fisheries Management and Development Act 2016*. The Government Printer. Government of Kenya.
- GoK. (2014). *Fisheries Annual Statistical Bulletin 2014*. State Department of Fisheries, Ministry of Agriculture, Livestock and Fisheries.
- Gutierrez, N. L., Hilborn, R. and Defeo, O. (2011). Leadership, social capital and incentives promote successful fisheries. *Nature* 470, 386–389.
- Haack, B. and Messina, J. (2001). *Satellite remote sensing: Monitoring the Omo River Delta in East Africa using remote sensing*. Earth Observation Magazine, UN-Water/Africa.
- Haambiya, L., Kaunda, E., Likongwe, J., Kambewa, D. and Chama, L. (2015). Towards Effective Stakeholder Participation in Comanagement through Fisheries Management Clinics. *International Journal of Fisheries and Aquatic Studies* 2(6), 248-254.

Hathaway, T. (2010). *Fighting for Lake Turkana. Why Kenyan communities are resisting the Gibbe 3 Dam*. International Rivers, Berkeley, CA, USA/ Brisbane, Australia.

ILEC. (2013). International Lake Environment Committee: World lakes database. Available at www.ilec.or.jp/database/afri/afri-20.html accessed 25th January 2018.

Kanyange, N., Kimani, P., Onyango, P., Sweenarian, S. and Yvergnaux, Y. (2014). *Performance Assessment of Beach Management Units along the coastlines of Kenya and Tanzania*. Indian Ocean Commission SmartFish Technical Report SF/2014/47. Available at <http://commissionoceanindien.org/fileadmin/projets/smartfish/Rapport/SF47.pdf>.

KMFRI/LTRP. (2007). Kenya Marine Fisheries Research Institute/Lake Turkana Research Project Technical Report /1: Lake Turkana: Fisheries, people and future intervention.

Linke, S. and Bruckmeier, K. (2015). Co-management in fisheries-Experiences and changing approaches in Europe. *Ocean & Coastal Management*, 104, 170-181.

Luomba, J. (2013). Role of beach management units in implementing fisheries policy: a case study of two BMUs in Lake Victoria, Tanzania. *Report, UN Fisheries Training Program*.

Mkumbo, O. and Marshall, B. (2014). The Nile perch fishery of Lake Victoria: current status and management challenges. *Fisheries Management and Ecology*.

Nunan, F., Cepic, D., Yongo, E., Salehe, M., Mbilingi, B., Odongkara, K., Onyango, P., Mlahagwa, E. and Owili, M. (2018). Compliance, corruption and co-management: how corruption fuels illegalities and undermines the legitimacy of fisheries co-management. *International Journal of the Commons*, 12 (2), 58–79.

Nunan, F., Onyango, P. and Hara, M. (2015). Institutions and co-management in East African inland and Malawi fisheries: A critical perspective. *World Development*, 70, 203-214.

Obiero, K. O., Abila, R.O., Murithi J. N., Raburu, P. O., Acheing, A. O., Kundu, R., Ogello, E. O., Munguti, J. M. and Lawrence, T. (2015). The Challenges of Fisheries Management: Recent Experiences in Implementing Fisheries Co-management in Lake Victoria, Kenya. *Lakes and Reservoirs: Research and Management* 20, 1–16.

Odada, E. O., Olago, D. O., Bugenyi, F., Kulindwa, K., Karimumuryango, J. and West, K. (2003). Environmental assessment of the East African Rift Valley lakes. *Aquatic Sciences*, 65, 254-271.

Onyango, P. O. (2014). *Strengthening Organizations and Collective Action in Fisheries: A Case study of Beach Management Units (BMU) in Lake Victoria Tanzania*. A Report Produced for FAO. Rome: FAO.

Onyango, P. O. and Jentoft, S. (2007). Embedding co-management: Community-based Fisheries Regimes in Lake Victoria, Tanzania, *In* M. Dickson, & Brooks, A. (Eds.), CBFM-2 International Conference on Community Based Approaches to Fisheries Management. *The World Fish Center Conference Proceedings* 75.

Otachi, E. O., Szostakowska, B., Jirsa, F. and Fellner-Frank, C. (2014). A snapshot of the parasite communities of the elongate tigerfish *Hydrocynus forskahlii* and redbelly tilapia *Tilapia zillii* from Lake Turkana, Kenya. *Acta Parasitology*, 60(1), 9-20.

Otachi, E. O., Magana, A. E. M., Jirsa, F. and Fellner-Frank, C. (2013). Parasites of commercially important fish from Lake Naivasha, Rift Valley, Kenya. Retrieved from DOI 10.1007/s00436-013-3741-4.

- Pathmanandakumar, V. (2017). The Effectiveness of Co-management Practices: The Case of Small-scale Fisheries in Sri Lanka. *Journal of Aquaculture Research & Development* 8: 509. doi: 10.4172/2155-9546.1000509.
- Quimby, B. and Levine, A. (2018). Participation, Power, and Equity: Examining Three Key Social Dimensions of Fisheries Comanagement. *Sustainability*,10, 3324: 1-20.
- Singleton, S. (2000). Cooperation or capture? The paradox of co-management and community participation in natural resource management and environmental policy-making. *Environmental Politics*, 9(2), 1-21.
- Try, I. and Sitha, H. (2011). Promoting Effective Fisheries Co-management through the Community Fisheries in Cambodia. *Fish for the People*, 9 (2), 73-78.
- Tweddle, D., Cowx, I. G., Peel, R. A. and Weyl, O. L. F. (2015). Challenges in fisheries management in the Zambezi, one of the great rivers of Africa. *Fisheries Management and Ecology*, 22, 99–111.