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SOCIOECONOMIC FACET OF FISHERIES MANAGEMENT IN HOMBOLO DAM, DODOMA - TANZANIA

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ABSTRACT

Assessment of fisheries activities in socioeconomic context is paramount if to guarantee adaptive co-management of the resources. The study investigated the status of fishing activities and documented the drivers threatening fish stock in the Hombolo Man-made Dam between January and October 2019. Semi-structured interviews, Focus group discussion, Key informants interviews, direct field observations and documentary review were employed to collect data. Content analysis, Statistical Package for Social Sciences version 20 and ERDAS software were used to analyze data. Results show the decline in amount of fish harvested (AFH) by 72.5% at $\beta \pm SE$: -0.99 ± 0.14, $t=-3.05$, $p = 0.003$ between 2011 and 2019. Similarly, number of fishermen and fishing boats decreased by 67% at -0.36 ± 0.71, $t=-0.24$, $p = 0.016$ and 53% at -0.58 ± 0.21, $t=-1.33$, $p = 0.006$ respectively between 2005-2019. The observed decrease in AFH, fishermen and fishing vessels perceived to imply the decline in the dam fish stock. Overfishing, population increase, poverty and inadequate law enforcement were perceived as drivers of fish stock attenuation. The study recommends further assessment of the dam ecology for effective fish restocking and provisioning of environmental education along with effective law enforcement for sustainable management of the dam.

Key words: Overfishing; Population growth; Irrigation farming; Land cover/land use change and Hombolo Man-made Dam.

INTRODUCTION

Sustainable practices have been a global questionable topic in the natural resources management. Water bodies like other environmental components are potential resources suffering devastating environmental pressure beyond their resilience capacity (Mulimbwa 2006; Carpenter and Kleinjans 2016). Scientific advice on the observance of fish limits to ensure adherence on the Total Allowable Catch (TAC) for commercial fish stock has not been respected (Mkama *et al.*, 2010; Glaser *et al.* 2018). Overfishing in the Atlantic regions has been documented to be attributed by the disregarding of TAC among Fisheries Ministers; For instance, in 2016, Ireland, Spain, and Sweden allowed fishing at 26%, 24%, and 23%, respectively, the percentage observed to be beyond their TAC as per scientific advice (Carpenter 2018). Demand for food and employment as well as waste production due to exponential human population growth in Africa have created irresistible threats to aquatic life across the continent (Machumu and Yakupitiyage 2013; Nunan *et al.* 2018). Habitat loss, waste discharge, decline in water quality and increased predation pressure are some of the adverse impacts caused by anthropogenic activities to many water bodies impairing specific needs to fish species (Van-der 2013; URT 2016).

Scientific studies including official documents and field visits have revealed several environmental impacts due to inadequate regulatory frame works during implementation of developmental programs (Nielsen and Holm 2007). Non-environmental Projects introduced in or around water courses have resulted into

decrease in water level and quality, destruction and loss of riparian vegetation and aquatic life (Njiru *et al.* 2014), slope instabilities and disruption of underground water resource due to tunneling (Government of Malawi 2010). A notable example is the establishment of developmental projects in fragile landscape and ecosystems such as wetlands in Uttarakhand, India that has adversely impacted biodiversity and produce environmental degradation (Pomeroy *et al*. 2001). Increased wetlands degradation, lack of proper land-use and management plans, absence of restoration plans for degraded wetlands and limited funds for enforcement of the existing guidelines are major challenges hampering conservation efforts of wetlands across sub-Saharan Africa (Nielsen and Holm 2007). Therefore, such improper environmental management of water bodies has contributed to loss of livelihood potentials from water resources, and loss of essential ecological and hydrological functions (Pomeroy *et al*. 2016).

Regarding Tanzania, destruction of fish habitat and environmental degradation of shorelines, inadequate fish assemblages, inefficient harvesting systems, stakeholder conflicts, as well as lack of institutional and political will are the main challenges in maintaining and enhancing fisheries basin and accruing associated socioeconomic benefits (Nielsen and Holm 2007, Pomeroy *et al*. 2016). Fisheries officers experience difficulties in articulating conservation interests against developmental decisions affecting aquatic environments (Lynch *et al.* 2017). Lack of reliable economic valuation and political thump by the users has resulted into poor representation and perhaps neglecting the needs of fisheries managers within existing political frameworks (Van-der 2013). The multi-sectoral nature of water resources development in the context of socio-economic development has not been recognized and addressed in harmony (Nunan 2010). Thus, lucrative investments have undermined the management and conservation efforts of aquatic natural resources (Van-der *et al.* 2014, Mkumbo and Marshall 2015).

Hombolo Man-made Dam (HMD) situated in Dodoma has the historical background of sustaining the local livelihood in the range of fishing, irrigation farming as well as water consumption for domestic use and livestock since its establishment in 1957 by the colonial government (URT 2013). However, since 2005 the dam has been experiencing acute decline in its potentials towards the targeted objectives (Shemsanga *et al.* 2017). The depth of the dam has decreased leading to decline in water volume and low fish harvests (Turner *et al.* 2019). Following the promotion of grape irrigation farming in Dodoma district, the motivated grape producers in Hombolo ward are competing to the available scarce water in the dam (Shemsanga *et al.* 2015). Livestock herders with their stocks evicted from Dodoma urban migrate towards rural areas including Hombolo ward as it is remotely located from city centre (Soka *et al*. 2013). Consequently, increases in livestock population in Hombolo ward roam along the buffer zones and shorelines of the HMD seeking for green pasture and water (Turner *et al.* 2019). Despite the HMD being potential in supporting livelihoods of thousands of people inhabiting in and outside Hombolo ward particularly on food security and protein supply, less is documented about the adverse impacts of socioeconomic activities on the dam fish stock. Few researches assessed the causes of increased salinity in the dam (Shemsanga *et al.* 2017) and providing evidence of native tilapia extinction due to stocking (Turner *et al.* 2019). Therefore, considering the integrity of Dodoma city, improving food security and protein sources through effective management of fishing activities to enhance fish stocks in the nearby water bodies like HMD is paramount. It is with this background the present study was carried out to assess the status of fishing activities and document the perceived drivers threatening fish stock in the dam.

The way forward to rescue this important asset is provided.

MATERIALS AND METHODS

The study was done in Hombolo ward within Dodoma Municipality, located between Latitudes 6.00 and 6.30 South, and Longitude 35.30 and 36.02 East (Shemsanga *et al.* 2017). The area is within a semi-arid region with low uni-modal annual rainfall of about 550-600mm per annum, which falls between December and April each year (Namwata *et al.* 2015). Mean daily temperature is lowest (13.0°C) in July and highest (30.6°C) in November with annual mean temperatures of 29°C (Shemsanga *et al.* 2015). Due to unreliable rainfall, the area has scanty vegetation such as shrubs, grasses as well as conspicuous baobab and acacia trees. The study focused on the HMD (Figure 1) established with 18 km^2 in 1957 to reduce the effects of flooding used to happen during wet season (DMC, 2011). It is primarily used by inhabitants of Hombolo ward for fishing, irrigation, domestic use and livestock. Thus, the prime economic activities in the study area are farming and livestock keeping (Shemsanga *et al.* 2017). The dam is inhabited by two species of fish to include tilapia (*Oreochromis niloticus*) and catfish (*Clarias gariepinus*).

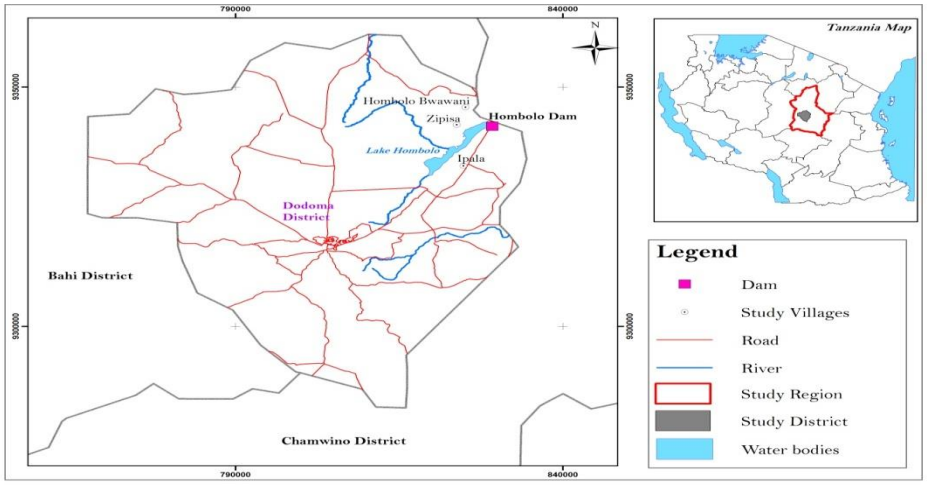


Figure 1: Map of Dodoma District showing the study villages. *Source*: Institute of Resources Assessment GIS lab, University of Dar es Salaam.

A cross-sectional research design was employed as it allows collection of data from selected individuals to represent the general population at a time about the information of interest (Punch, 2014). Poate and Daplyn (1993) formula was used to determine the sample size for the study:

$n = \underline{Z^2\ C^2}$ Where; n = sample size used,

Z = 1.96 at 95% confidence interval

X^2 C = 50%, variation within the population as no previous studies were found

X =5%, estimated level of accuracy.

Thus,

$$n = \frac{(1.96)^2(50)^2}{(5)^2}$$

$$= 384.16 \approx 384$$

Due to limited resources available in terms of time, manpower and finance, the sample size of 300 respondents was used for household questionnaire survey for three villages of Zepisa, Hombolo-bwawani and Ipala. Through stratified random sampling within the ward, 10% of the respondents were sampled from each study village (Table 1) as per human population statistics (DMC, 2011).

Systematic Random sampling was used to identify the households as the sampling units in the study villages. Participants for

focus group discussions (FGD) and key informants interviews (KII) were purposively sampled based on their adequate knowledge and specialization in relation to the subject under investigation

Table 1: Sample size

Villages	Population surveyed	Sample
Zepisa	986	95
Ipala	892	85
Hombolo-bwawani	1316	120
Total	**3194**	**300**

. A total of 10 FGDs involving about 80 individuals were carried out across the study area focusing on all community groups (youth, women, adult males and elders) each one addressed separately as they perceive things differently. KIIs were administered to seven (7) participants to include 1 Municipal Fisheries Officer, 1 Municipal Livestock officer, 1 Municipal Agricultural Officer, 1 Ward Executive officer and 3 Village Executive Officers from the selected study villages. Qualitative data such as descriptive statements about fishing process and other related anthropogenic activities occurring in the dam were analyzed through template technique in which relevant information was translated and categorized into various themes and sub-themes as per study objectives. Afterward, quantitative data from questionnaires mainly factors threatening the dam and measures to be taken to rescue it were processed and analyzed using Statistical Package for Social Sciences (SPSS). Obtained data were presented in tables and figures.

The Remote Sensing (RS) and Geographical Information System (GIS) tools were used to analyze vegetation cover changes in the study area between 1990 and 2018. The downloaded satellite images from USGS website were processed in ERDAS Imagine 15 software followed by image classification that involved errors reduction to enhance image brightness for proper interpretation and analysis of the digital images. The existing land covers/land use such as forest, bush land, grassland, cultivated land, settlement and wetland/dam were defined through the satellite images with inherent elements like size, color, shape, shadow, texture, association and pattern in order to carry out image interpretation. Arc GISv10 was used to convert raster data into vector data followed by actual analysis to yield the output which were finally analyzed in the Arc map. The land cover/ land use types detected were generated in excel file to identify changes presented in hectares and percentages in the forms of table.

RESULTS AND DISCUSSION

Socioeconomic characteristics of the respondents

Data on socioeconomic characteristics varied across the study villages (Table 2). Majority of the respondents were males (76%, n=300) the scenario that could have been attributed by the fact that males are the households' heads in the study area hence responsible for speaking on the matters related to family issues. As for age, 79% were of 18-50 years old depicting the population to be most economically active. Regarding education, the study area is characterized by high illiteracy level especially on matters requiring broad understanding and critical thinking. This is due to high population (82%) had only either informal or primary education. Farming is the main (69%) economic activity in the area.

Fishing activities in Hombolo Dam

Hombolo Dam at present supports fishing activities to about 40 permanent, full-time fishermen and more than 50 part-time fishermen. Simple fishing gears are used including traps, hooks, cast nets, gill nets, seine nets, dugout canoes and dhows. However, some use wooden boats with engines. Fishing nets are set in the evening and left overnight in the dam to be hauled in the morning while other carryout fishing during day and/or night, constantly monitoring the nets and retrieving them after

every few hours. The use of seine nets caches adults and juvenile fishes in the dam.

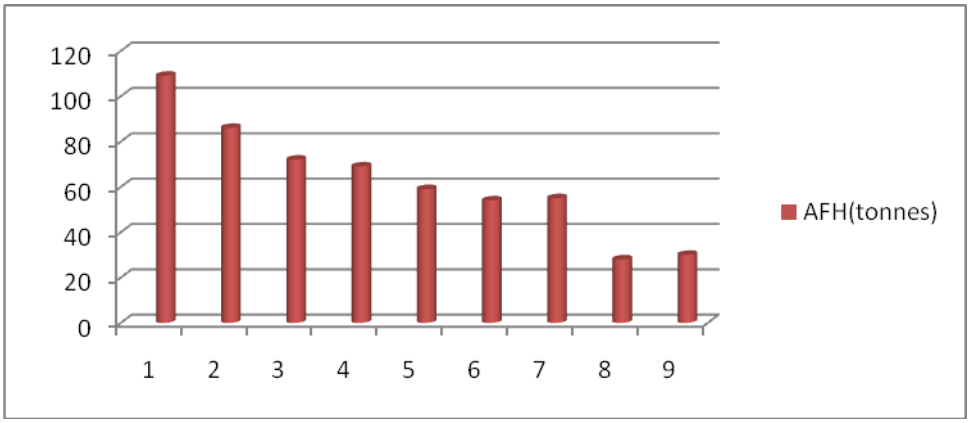
Regarding fish catch, the study found out that, Hombolo dam has been progressively declining in the amount of fish harvested (AFH) from 109 tons in 2011 to 30 tons in 2019 (Figure 2). The records for years before 2011 were missing. The trend in AFH depicts the significant decline of 72.5% at β ± SE: -0.99 ± 0.14, t=-3.05, p = 0.003 between 2011 and 2019.

Table 2: Socioeconomic characteristics of the respondents

Villages	Sex (%)		Age categories (%)			Education level (%)				Economic activities (%)			
	M	F	18-34	35-50	>50	IE	PE	SE	C/U	FA	LI	FI	O
Zepisa	72	23	36.7	45.3	18	41.4	45	12	1.6	74.7	6.3	17	2
Hombolo-bwawani	96	34	31	44	25	14.6	61	19.4	5	65	15	16	4
Ipala	70	15	31	49	20	33	53	10	4	66.4	12.6	18	3
Total	228	72	98.7	138.3	63	87	159	41.4	12.6	206.1	33.9	51	9
Average	76	24	32.9	46.1	21	29	53	13.8	4.2	68.7	11.3	17	3

n=sample, IE=informal education, PE=primary education, SE=secondary education, C/U=college/university, FA=farming, LI=livestock keeping, FI=fishing, O=others.

Source: *Field data, 2017*



Where: AFH= Amount of Fish Harvested, 1=2011, 2=2012, 3=2013, 4=2014, 5=2015, 6=2016, 7=2017, 8=2018, 9=2019 years

Figure 2: Historic trend of fish harvested in Hombolo Dam between 2011 and 2019. Source: Dodoma Municipal Office, 2019

Decrease in fish productivity within the dam was also revealed through FGD as one of the discussant stated that, "*the plummet in fish catch per effort in Hombolo dam is apparent, in the past it was common for a fisherman to catch about 100kg of fish per day unlike now where sometimes even to get 3kg per day is rarely possible"*. Decline in HMD fish stocks could be due to increased illegal fishing and sedimentation in the dam that affect the breeding sites for fish.

The concequences of loss in fish stocks in the study area prompted some fishermen to leave the dam. Statistics shows that number of fishermen and that of fishing boats has a signficant declines of 67% at -0.36 ± 0.71, t=-0.24, p = 0.016 and 53% at -0.58 ± 0.21, t=-1.33, p = 0.006 respectively between 2005-2019 (Table 3). Such decrease in fishing activities could entails that the dam is no longer capable to sustain the livelihood of local communities especially fishermen. Through FGD, participants asserted that fishermen fall into three main categories

such as migrant fishermen, fishermen farmers and sedentary fishermen. The migrant fishermen are solely depending on fishing activity while the fishermen farmers are engaged in both farming and fishing. The last category (sendentary fishermen) do opt fishing activity when the fish stock is abundant otherwise they switch solely on agriculture or any other livelihood strategies. Decrease in fishing activity due to low dam productivity resulted into decline in fishermen number as majority were migrant fishermen who left HMD to other fishing areas.

Perceived drivers of decline of fish stock

Overfishing was mentioned by the majority (39%) of the respondents as the major reason for decreased fish stock in the study area (Figure 3).

Table 3: Njmber of Fishermen and Boats at Hombolo Dam between 2005-2017

Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Fishermen	127	112	105	97	95	98	90	95	87	60	48	57	51	53	42
Boats	83	83	81	64	64	64	64	59	53	47	44	45	45	39	39

Source: Dodoma Municipal Office, 2019

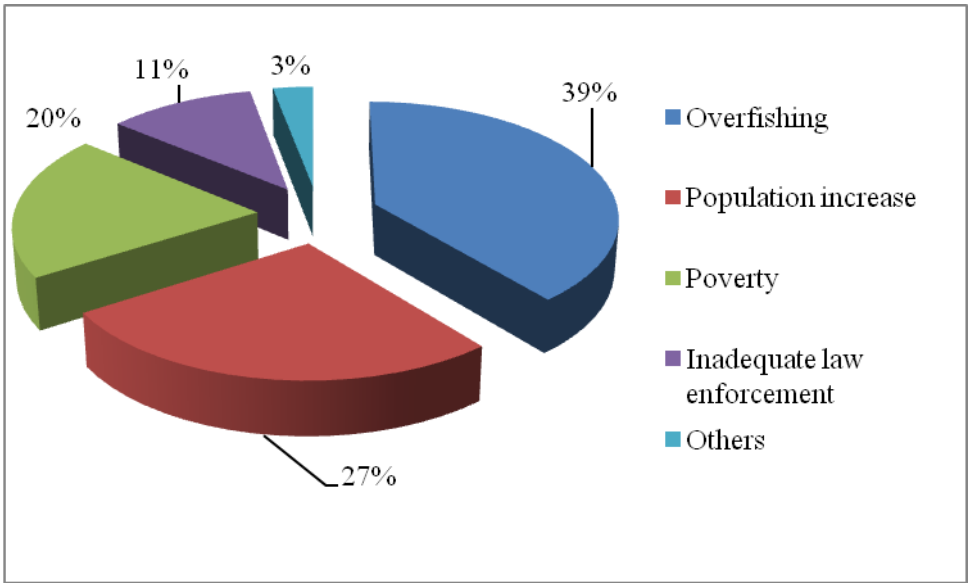


Figure 3: Major drivers of fish stock decline in HMD perceived by respondents

Respondents attributed overfishing with the use of destructive fishing gears such as fishing traps and seine nets which were common in the HMD. The study observed undersize fish of approximately 15mg (6cm) being harvested from the dam as shown in figure 4 while the recommendable size for harvesting is 250mg (15cm) for tilapia (URT 2016).

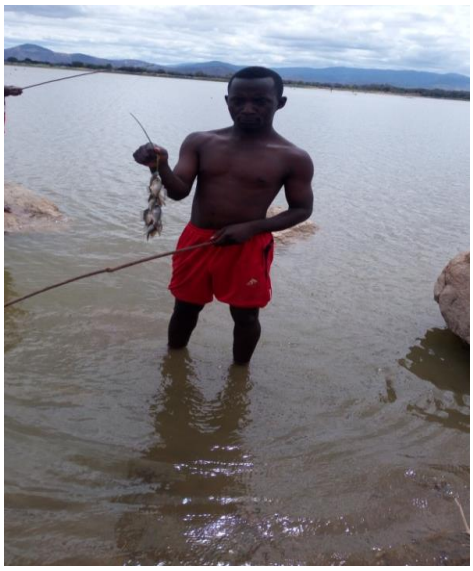


Figure 4: Fisherman with under size fish from Hombolo Dam

Harvesting of undersized fish from HMD was also reported by Turner *et al.* (2019) that despite stocking efforts for fishery enhancement resulting to local extinction of native tilapia (*Oreochromis urolepis*), the dam experiences fishing of the undersize introduced two non-native tilapia species (*O. niloticus* and *O. esculentus*) between 2014 and 2017.

Human population increase, as perceived by 27% of the respondents, was another factor for the observed decline of fish stock in HMD (Figure 3). Over the past decades the study area experiences a constant human population increase (Figure 5). It was reported that Hombolo Division is the only area with highest household size (4.6) in Dodoma City with sex ratio of 1:1 (URT 2012). The observed population growth could suggest high fertility level and/or increased immigration. As for immigration, the increased grape irrigation farming and socioeconomic development ignited by introduction of Local Government Training Institute at Hombolo were identified as the main drivers.

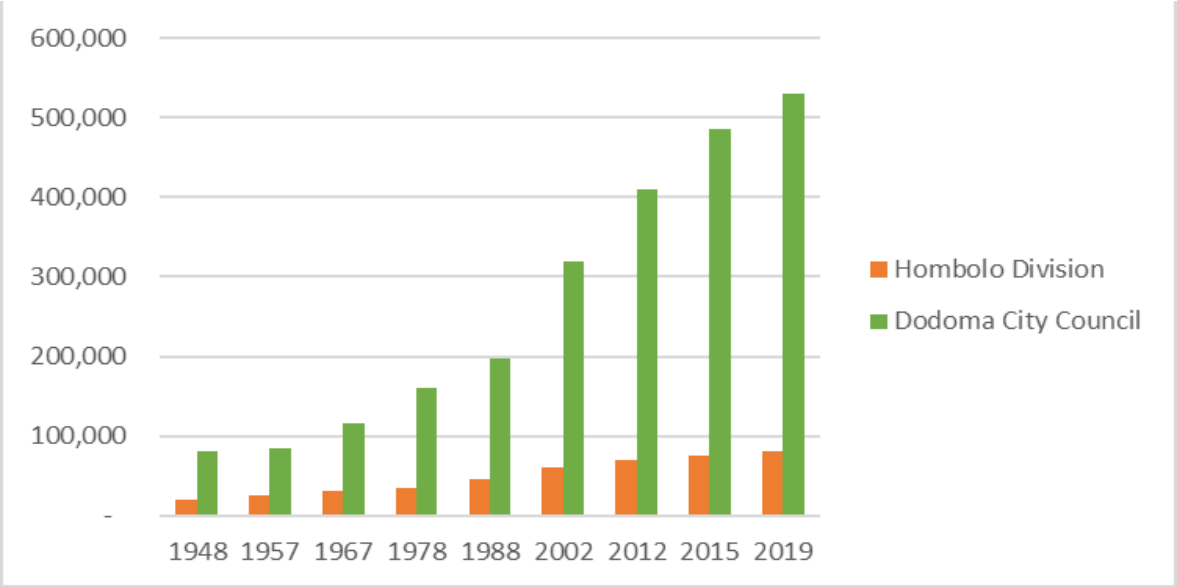


Figure 5: Human population in Hombolo division and Dodoma City Council. *Source*: Socioeconomic profile for Dodoma City Council, 2015

Despite the high salinity of water in the Hombolo dam (Shemsanga *et al.* 2017), the observed population growth supported the diversity of socioeconomic activities directly depending on the dam. These include grape irrigation farming, livestock watering, domestic water supply and fishing activities. The mentioned activities being unregulated have induced high pressure to the dam interfering its natural capacity of fish production. For instance, for more than a decade the dam has been experiencing intensive illegal fishing throughout a year.

This situation does not allow fish to grow to reach maturity for effective reproduction.

The study observed that most of the local communities surrounding the Hombolo dam are heavily engaged in grape irrigation farming (Figure 6) such that about 684 farmers have cultivated more than 300 hectares. The existence of growing market for grape and its related products (Kalimang`asi *et al.* 2014) has influenced the grape irrigation farming among many farmers in Dodoma Municipality including Hombolo ward. For that reason, there has been increasing drawing of water from the dam for irrigation purposes a situation that has resulted to a significant decrease in water level hence threatening fish growth and reproduction. According to the Municipal Fisheries Officer, it was agreed that the farmers were required to draw out only the excess water overflowing above the meter level placed on the outlet (Figure 7) and watering the farms was suggested to be once a week to avoid over draining out of the dam.

Figure 6. Grape Irrigation farming in Hombolo

But the study observed that the high water demand for the considerable development of irrigation violated the rule such that farmers are draining out the dam whenever they want to irrigate irrespective the water level. Despite that, there is no formal policy for water abstraction from the dam, the Municipal Agricultural officer clarified that they agreed among users that, the allowable amount of water to be abstracted from the dam for irrigation is 7150 liters per hour.

Figure 7. Meter recording the water level in Homboloward

But he said that, currently the amount of water abstracted from the dam for grape irrigation is approximately twice the allowed quantity.

The areas used to be over flooded in the past is now apparently dry due to excessive water abstraction. The observed decrease of water level in HMD due to over draining of water for irrigation farming had also indirect effect on fishing activity. Through FGD it was revealed that some fishermen after realizing more potential in grape farming than fishing they turned on farming that increased water abstraction from the dam. Municipal Agricultural officer stated that *"within the period of five years ago there has been a significant increase in number and size of irrigated farm fields"*. The constant drawing of much water from the dam every day for irrigation farming especially during dry season could be the main factor contributing to the observed decrease in dam water level. The findings concur with the study by Lynch *et al.* (2017) reported that the ecological status as well as trends of rivers and wetlands in Tanzania is critically threatened by the mega irrigation schemes diverging water from seasonal rivers. Such process hampers the conservation efforts of sensitive freshwater and wetland habitats supporting wide range of aquatic life.

Increase in cultivated land use and decrease in vegetation cover detected through RS and GIS tools in the study area confirmed the increased agricultural activities including grape irrigation farming reported through a household survey (Table 4). For instance, between 1990 and 2018 area cover in forest, bush land and grassland declined by -76 ha (or -8.9%), -14477 ha (or -59.3%), -4769 ha (or -65.9%) respectively. Similarly, in the same period the cultivated land and settlement increased by 8550 ha (or 43.4%) and 709 ha (or 35.3%) respectively entailing indirect effect of population growth. The land cover/land use changes recorded by the present study could imply the increased pressure on the natural resources (vegetation) among communities around HMD.

Table 4: Land cover/land use changes in the study area during 1990, 2005 and 2018

Land use type	Cover in Ha			Changes (Ha) 1990-2018			Changes (%) 1990-2018		
	1990	2005	2018	1990-2005	2005-2018	1990-2018	1990-2005	2005-2018	1990-2018
Forest	935	905	859	-30	-46	-76	-3.21	-5.1	-8.9
Bush land	12,030	8,555	7,553	-3475	-1002	-4477	-28.9	-11.7	-59.3
Grassland	12,007	9,086	7,238	-2921	-1848	-4769	-24.3	-20.3	-65.9
Cultivated land	11,147	15,828	19,697	+4681	+3869	+8550	+42.0	+24.4	+43.4
Settlement	1,298	1,784	2,007	+486	+223	+709	+37.4	+12.5	+35.3
Wetland/dam	980	971	965	-9	-6	-15	-0.9	-0.6	-1.6
Total	38,334	38,334	38,334						

Where; (+) means increased; (-) means decreased

Livestock grazing along the water banks and buffer zones of the dam exacerbated soil erosion leading to high rate of sedimentation. According to the Municipal Fisheries Officer, the water depth has decreased from 11.5m which was formally known when the dam was established to less than 5m to date. Livestock mobility along the shorelines of the dam disturbs and perhaps destroying fish breeding sites when drinking water and grazing the riparian vegetation. The dam was estimated to support about 3,573 cattle, 254 goats and 69 sheep but the livestock population increases during dry season. The study found that population increase of both human and livestock coupled with non-environmental socioeconomic activities around HMD is the major threat to aquatic life including fish stock. This finding is supported by other similar studies elsewhere, for instance, Hongoa (2014) found that, the growing human population around lake Babati, Tanzania was the major driver of land use changes and land cover changes affecting biodiversity in and around the lake. Silting and eutrophication due to increased irrigation farming coupled with application of pesticides and fertilizers at Mto wa Mbu and Mang'ola affected the biodiversity found in Lake Manyara and Lake Eyasi respectively (Yanda and Madulu 2005). Therefore, adaptive and participatory management approach by all relevant stakeholders is required for effective conservation of water bodies against ongoing degradation.

Increased poverty among the local communities bordering the HMD was another driver perceived by 20% of the respondents (Figure 3). Like other natural resources located in rural or semi-urban environment bordered by poor communities experience illegal off takes, the HMD suffers from extensive illegal fishing. Such unregulated fishing was associated with abject poverty among some local people in the study area. This was revealed through focus group discussion as one of the discussants states that, "*we are engaging in illegal fishing not because we don't know the negative consequences of it, but*

starvation and poverty drive us to do so." Similarly, Municipal Fisheries Officer acknowledged that most of the accused individuals for illegal fishing were the poor men and women who complained to engage in overfishing just because of poverty. The results are supported by the report of international development agencies in 2002 which estimated that more than 90% of the 15,000,000 people in the world who depend on small scale fishing are poor (FAO 2002). Similarly, the findings are in consistent with Bene (2004) who reported that poverty is endemic to fisheries and most of small-scale fishing communities in developing countries are the most disadvantaged group of the rural societies. According to conventional wisdom theory by Copes (1989), the open access nature of the fisheries sector is the actual reason for poverty among fishermen as it allows more and more people to enter fishing sector leading to the economical and biological overexploitation of the resources, collapse of the payment and finally impoverishment of the fishing community. Poverty in fisheries is thus linked to the intensity of utilization of the resource such that over-exploitation happened in the past resulted to low fish catch and low income consequently poverty.

Inadequate law enforcement was reported by 11% of the respondents as another factor for the observed illegal and unregulated fishing in the dam (Figure 3). The dam is subjected to intensive fishing activities throught a year a situation that could have resulted to the observed overharvesting. One of the key informants asserted that, "*lack of adequate fund to facilitate regular patrol in and around the dam limits the effective management to combat illegal fishing. Patroling fishing activities within the dam should be a continuos process, but it is done once for five to seven days within a quarter of a year"*. It was observed that illegal fishing gears such as beach seine are commonly used in the Hombolo dam. Beach seine harvest even the undersize fish and destroy the fish breeding sites (Wells, 2009). The study revealed that lack of management control through regular patrol across the dam could be the reason of the ongoing unsustainable fishing. This finding is supported by other studies reporting lack of joint efforts among responsible authorities in regulating fishing activities across the country has excerbated overfishing. For instance, illegal, unreported and unregulated fishing devastated Nile perch biomass in lake victoria from 2,300,000 to 300,000 tonnes between 1999 and 2008 (Etiegni *et al*. 2011). Leuven (2020) reported decrease in Lake Tanganyika fish stock by 25% between 1995 and 2011 mainly due to use of illegal fishing gears. The mean catch per unit effort in northwest part of Lake Tanganyika decreased from 319.6 kg to 169.4 kg between 2012 and 2013 (Cirhuza *et al.* 2015). Nyumba ya Mungu hydroelectric dam used to produce 25,000 metric tons of fish per year in 1970s, but the productivity decreased to about 11 metric tons in 2016 due to illegal fishing and drought (Glaser *et al.* 2018). Thus, for sustainable management of water bodies and the conservation of associated resources for improved livelihood development effective control of fish harvesting pattern is obligatory to combat the ongoing illegal fishing across the country. Inadequate law enforcement in the study area led to an encroachment of the dam buffer zones for settlements and farming despite the legal prohibition of using land of 60m from the water bodies (URT 2014). Water usage from the dam without proper observance enforcement of the sustainability principles induced localized pollution through domestic wastes.

Other factors perceived by the respondents as the causes of fish stock decline in the Hombolo dam include destruction of breeding sites due to poor fishing methods such as usage of beach seine. Stagnant growth of fish as the dam has not been restocked (replanted) for many decades since its establishment in 1957 and decreased depth of the dam due to soil erosion and sedimentation exacerbated by increased anthropogenic activities in the

shorelines were also reported to decrease fish stock in the area.

When respondents were asked to suggest mechanisms of restoring the dam for sustainable conservation of the resources found in it, various approaches were recommended. Closing of the dam (37%) and provisioning of environmental education (31.6%) were cited by the majority of the respondents as the appropriate means of controlling the problem of overfishing and environmental degradation in HMD (Figure 8).

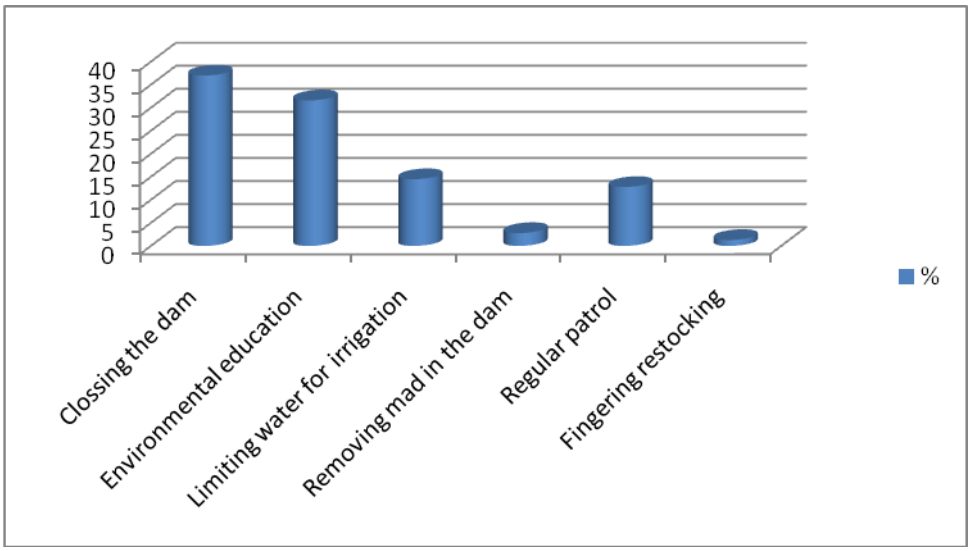


Figure 8: Suggestive measures to control environmental degradation in HMD

The Fisheries Officer clarified that, the Dodoma City Council in collaboration with the Ministry of Livestock Development and Fisheries are planning to close the dam immediately after restocking the fingerings to facilitate fish growth for the better and sustainable harvests in future. However, it was realized that, there is a need of carrying out a thorough study of dam ecological assessment before fingering restocking for sustainable fisheries management. Inadequate research fund limited the present study to explore the ecological aspect of the dam hence suggesting further investigation of the subject.

Through FGD, the discussants suggested that in the continuous bases environmental education and regular patrol should accompany the process of fish restocking and closing of the dam to create awareness among rural communities. Effective law enforcement should be guaranteed to prevent people who disregard the laws and destruct the resources. The study found that understanding and attitudes among respondents in the study area was not uniform. Some individuals are willing to conserve the dam while others are completely pessimistic and objectionable to the HMD bylaws. This was clarified by the leaders of beach management units (BMU) who are responsible for the dam patrol. One of the BMU-leaders cited that, *"some villagers support the introduced dam conservation initiatives and comply with the regulations for sustainable resources utilization while others defy the rules and engage in illegal activities threatening the dam sustainability*. Such argument can be explained by the fact that difference in socioeconomic characteristics among rural members entails that local communities managing the communal natural resources have diverse interests towards the resources under conservation. It was observed that

local people in the study area whose livelihood strategy (e.g., fishermen and irrigation farmers) is directly linked with the dam resources were relatively reluctant to accept the idea of closing the dam. This necessitate that sensitization program on the importance of dam closing should be done prior to actual process. The disparity among rural dwellers on management of communal natural resources was also reported by Hongoa (2014) that, illiterate, fishermen and farmers around lake Babati, Tanzania were highly involved in breaking the lake bylaws than other community groups. Therefore, for effective management of natural resources through community engagement responsible authorities should consider the interests diversity among local people as an integral determinant. Disregarding heterogeneity among community in decision making about conservation of communal resources impede the efforts and initiatives put forward to achieve the desired sustainable management.

CONCLUSION AND RECOMMENDATION

Hombolo Man-made Dam has experienced an acute decline in fish stock. Statistics from Dodoma City Council indicated a substantial decrease in fish catch by 72.5% from 109 to 30 tons between 2011 and 2019. Due to reduced fish stock in the dam, fishing activities also decreased as the number of fishermen and fishing boats revealed do decline by 67% and 53% between 2005 and 2019 respectively. Various factors revealed to drive the decline of fish stock in the dam to include overfishing, population increase, poverty and inadequate law enforcement. Closing the dam, environmental education, regulating water abstraction for irrigation and enforcement of regular patrol were suggestive measures to rescue dam resources against ongoing degradation. Therefore, the current study realized that fishing activities within the dam is less organized, unregulated and done with little supervision of the responsible authorities the scenario attributed to overfishing. Regardless of the ongoing fish resources degredation, some of the inhabitats of the study area admitted to support improvement of the dam conservation initiatives. This provide an opportunity to responsible authorities to develop and enforce effective legal frameworks for the sustainable management of the fisheries resources in the study area. Therefore, the study recommends further investigation of the dam ecological environment to ascertain the adverse impacts associated with ongoing athropogenic activities, rehabilitation of the dam environment including fingerings restocking, provisioning of environmental education to the public about the impacts of their malpractices along with effective law enforcement.

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