ANTHROPOGENIC FORCES AND THE DEPLETION OF WETLANDS AROUND LAKE RUKWA IN SUMBAWANGA DISTRICT, TANZANIA

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Abstract: *The study set to assess how anthropogenic forces contributed to the degradation of wetlands around Lake Rukwa in Sumbawanga district, thereby depleting the lake and its resources. Specifically, it assessed how the human activities deplete the wetlands of Lake Rukwa; examined the human influence on the changes in depth and width of Lake Rukwa overtime and evaluated the awareness of people about the impacts of their activities on wetlands of lake Rukwa. Data were collected from randomly selected samples from the clusters of crop cultivators, pastoralists, fishermen, ward leaders and natural resource managers of Sumbawanga district. Methods of data collection included: interview, observation, physical measurement, documentation and administration of the questionnaire. Confirmatory Data Analysis (CDA) was used to link the relationship between human forces and the depletion of Lake Rukwa wetlands and to draw a conclusion. Findings revealed that, there was a big link between the depletion of Lake Rukwa wetlands, the shrinkage of the lake and the anthropogenic forces taking place around the lake. The study recommended that land users and stewards of Lake Rukwa in Sumbawanga district, be educated on the impacts of their economic activities on the lake resources and how to exploit them sustainably.*

Key words: Anthropogenic forces in Rukwa basin, Lake Rukwa wetlands, Wetlands loss in Tanzania, degradation of Lake Rukwa, Land degradation in Lake Rukwa basin**.**

INTRODUCTION

Wetlands according to the United States Geological Survey are areas where water covers the soil, or is present either at or near the surface of the soil all year or for varying periods of time during the year, including during the growing season. Wetlands vary widely because of regional and local differences in soils, topography, climate, hydrology, water chemistry, vegetation, and other factors, such as human disturbance. This has given rise to a variety of wetlands:-marshes, swamps, potholes, bogs, and fens. Indeed, wetlands are found on every continent except Antarctica and fall into two general categories: coastal (tidal); and inland (non-tidal) (Yuhas, 1996). Inland wetlands can be found around water bodies such as lakes, rivers and reservoirs.

Wetlands are useful to both human beings and the environment in various aspects. Wetlands yield fuel wood for cooking, thatch for roofing, fibers for textiles and paper making, and timber for building. Medicine is also extracted from tree barks, leaves, and fruits. They also provide tannins and dyes, used extensively in the treatment of leather. Moreover, wetlands clean the water by filtering out sediments, decomposing vegetative matter and converting chemicals into useable form. The ability of wetlands to recycle nutrients makes them critical in the overall functioning of the earth because there is no other ecosystem that is as productive, and as unique in this conversion process (Missouri Botanical Garden, 2002).

Human beings tend to migrate from resource deficient areas to exploit wetlands to meet their various needs. This practice is attributable to the degradation and loss of wetlands worldwide. Population increase over the years and its accompanied demands for agricultural expansion, pastoralism, lumbering and other economic activities are drivers for an ever increasing demand for wetlands worldwide which ultimately lead to loss of wetlands in many parts of the world (Bierkens *et al*, 2010).

The global extent of wetlands is now estimated to have declined between 64-71% in the 20th century, and wetland losses and degradation continue worldwide. Adverse changes to wetlands,

including coral reefs, are estimated to result in more than US $ 20 trillion in losses of ecosystem services annually (Punta del Este, 2015).

In the 1600's, over 220 million acres of wetlands existed in the United States of America. Since then, extensive losses and degradation of the original wetlands have occurred through agriculture; silviculture commercial and residential development; road construction; impoundment; resource extraction; industrial siting, and waste dredge disposal and mosquito control. Today, less than half of the nation's original wetlands remain (Yuhas, 1996).
Since the advent of industrialization and urbanization the wetlands came under severe threat due to increased anthropogenic pressure. As per an estimate, India has lost 38% of its wetlands between 1999 and 2001 alone. Urbanization and land use in India for the period of 1990s was rapid leading to a high increase in urban population. This magnitude of growth exerted tremendous pressure on wetlands and flood plain areas for meeting water and food demand of the growing population (Jagran, 20016).

In Latin America, recently, human activities have been threatening the valuable wetland environment of the Pantanal. Traditionally, the temporary grassland that exists during the dry season is used for cattle ranching, thus causing environmental problems in the region (Keiichiro, 2006).

In Africa, wetlands make up about 1% of the total surface area. Many wetlands are found between 15°N and 20° S. They include wetlands of major riverine systems such as the Nile, Niger and the Inner Niger delta, Congo, Zambezi; Lake Chad, Victoria, in the Rift valley lakes- Lake Tanganyika, Nyasa, Turkana, Rukwa, Mweru, Natron, Manyara, the Sudd in Southern Sudan and Ethiopia, the Okavango Delta in Botswana, Swamps of Western Tanzania and the coastal wetlands (Kabii, n.a). All these are rich in biodiversity, both in terms of species and endemism. They are also very productive supporting a large rural population in Africa in terms of food, water and fuel energy, medicine, building materials, dry season grazing (in the Inner Delta of the Niger, Kafue flats and the Lake Rukwa basin). Most of the African large mammals such as the Hippopotamus and crocodiles on which tourism is famous, are often linked to wetlands (eg Masai Mara) (ibid).

Tanzania is well endowed with many wetlands. It is estimated that 7% of the country is covered by wetlands. The four main Ramsar Sites include: the Kilombero valley flood plain, Lake Natron basin, Malagarasi- Muyovozi wetlands, and the Rufiji-Mafia-Kilwa Marine Ramsar Site (Ramsar Convetion Secretariat). Wetlands of Tanzania are a valuable resource on which, majority of the inhabitants depend for their livelihoods. Wetland ecosystems being relatively rich and fertile support a number of economic activities such as farming, fishing and grazing. The fertility and production potential of wetland areas has occasioned large scale migration of agro pastoralists from degraded areas in the north west (Sukumaland) to wetland areas in south western Tanzania where Lake Rukwa is situated (Musana, 2018).

Many wetlands are rich in migratory wildlife which provides important recreational and food resources and commercial products including hides, skins and trophies for which Tanzania is well known. Nonetheless, due to unsustainable human economic activities carried out in these areas, their existence is under threat. Human activities have caused some species in wetlands to become endangered while others are threatened with extinction (Kamkala G.L, 2001). Areas which have suffered land degradation as a result of overgrazing are the Usangu flats and Kilombero valley (URT, 2009) as well as the Lake Rukwa basin where the situation is increasingly becoming intense due to high influxes of agro-pastoralists into the basin (Musana, 2018).

Owing to population increase and prolonged droughts the wetlands of Lake Rukwa are over cultivated and overgrazed thereby threatening their sustainability. Efforts made by government to address the problem include; the destruction of slums of people who cultivate, graze livestock and cut timber in the wetlands close to the lake. Moreover, people who violate the bylaws set by the Sumbawanga district council are sent to the court of law where culprits have to pay fines.

Despite these efforts, the threats to the survival of the lake and its wetlands have persisted. Crop cultivators and migrant agro-pastoralists continue to encroach on the wetlands while loggers

continue with timber harvesting in the lake basin. Seemingly, wetlands are being degraded due to improper implementation of regulations over their use. Long term sustainable practices have not been implemented to preserve the available limited wetlands. Consequently, Lake Rukwa is likely to change into a pond by 2023 if the ongoing environmental degradation will not be urgently mitigated (http://www.fikrapevu.com/).

Most of the literatures have stressed much on the disappearance of the wetlands on the earth's surface as a result of human forces. However, most of the reviews have not shown whether the local users of wet lands such as local farmers and pastoralists in Tanzania are aware of the impacts of their activities on sustainable existence of the wetlands. Additionally, researches done on Lake Rukwa have not dealt with its wetlands depletion in relation to anthropogenic forces. Instead, they have linked the lake ecosystem degradation to the lake basin's changing climatic condition.

Arising from the above, this study set to assess the role played by anthropogenic forces in the depletion of wetlands around Lake Rukwa in Sumbawanga district, Tanzania, so as to come up with practical recommendations for sustainable use of the lake resources. This was deemed significant because it addressed the international Sustainable Development Goals; number 1(end poverty), 2 (end hunger), and 15 (life on land- sustainable use of terrestrial ecosystems) and the Tanzania Environmental Policy of 1997.

MATERIALS AND METHODS

The study was conducted in the Lake Rukwa basin portion situated in Sumbawanga district in South Western Tanzania in 2015. This is an inland drainage sink with no outlets, which lies within the western arm of the East African Rift Valley, between latitude $7^0$50'0" and 7.8333'; and longitude $33^0$9' and 32.1600 (refer Figure 1).

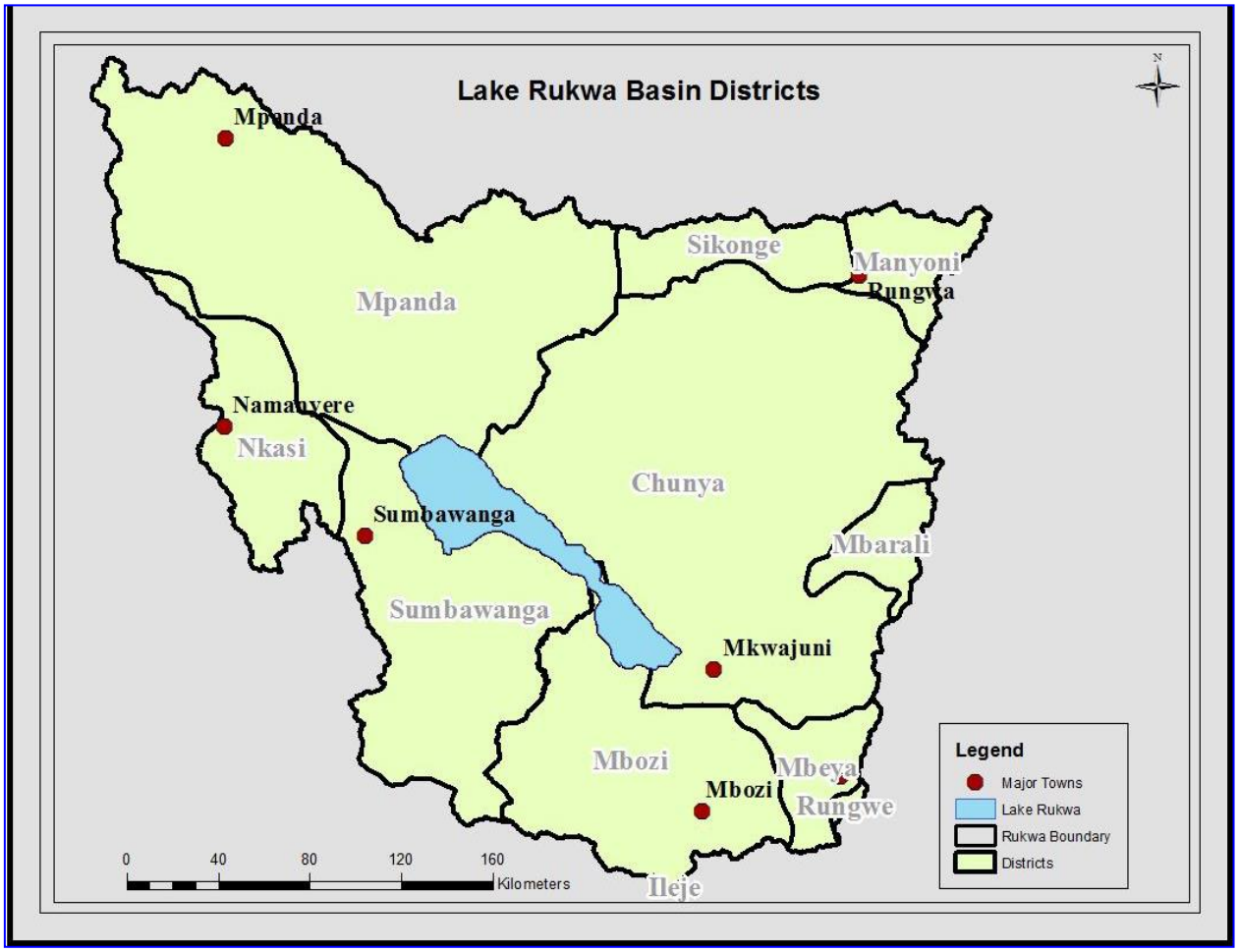

Figure:1 Lake Rukwa basin districts

Source: WELAREM1 (2001)

Lake Rukwa lies in a tropical wet eco region and has a large floodplain (about 1,300 square km) along the northern shore that is inundated during the rainy season during which ephemeral rivers flow into the lake together with major rivers. Major rivers draining into lake Rukwa include, the Rungwa, Momba, Lupa, Chambua and Songwe rivers. The northern basin is quite shallow and occasionally dries out. The southern basin reaches maximum depths of 15 meters. The water level in the lake has been rising since the late 1980's due to silting (LakeNet). Silting has reduced the lake's depth.

Sumbawanga district exhibits a tropical climate. temperatures are highly variable depending on altitude, ranging from 12ºC in the highlands to about 30ºC in the lowland areas of the basin. Seasonally, temperatures are high during September to December, cool during June and July and fairly warm for the rest of the year (URT, 2013). The rainy season runs from November to mid-May with annual rainfall ranging from 800mm (in the Southwest) to 1,300mm (in the Northwest). Due to these climatic conditions, Sumbawanga district has got three distinct ecological systems exist namely; the Ufipa plateau, Rukwa basin and Lake Tanganyika shores. The Ufipa Plateau is characterised by grassland, accounting for about 60% of the total district area. This zone serves as a major agricultural production zone for maize, beans, sunflower, finger-millet, groundnuts, wheat, sugarcane and vegetables. Livestock such as cattle, goats, poultry and pigs are also kept in the area. Lake Rukwa Basin which lies between Lyamba-lya-Mfipa escarpment and Lake Rukwa accounts for 30% of total district area with fishing as the major activity and over (see Figure 1). 50% of Sumbawanga's livestock is reared here. Because of slight variations in grade, flooding is common. The area is surrounded by Uwanda game reserve, where due to population increase the reserve is now threatened by human activities such as crop cultivation, animal grazing and lumbering. Lastly, Lake Tangayika Shores account for about 10% of Sumbawanga's area with the major activity being fishing (URT, 1998).

According to the National Bureau of statistics (2012) the human population of the area was estimated to be 22,600. The major economic activity practiced by majority of people in the area was agriculture.

Research Approach and design

This study used the Pragmatic approach (mixed methods) to collect information in the field. This approach enabled the researcher to use different techniques at the same time or one after the other in order to crosscheck responses from various methods. A phenomenological research design was employed and used a qualitative approach to gather data from a sample of 65 respondents. The target population included the crop cultivators, pastoralists, fishers and loggers who were conducting their activities along the lake. The local government leaders and district natural resources managers were also involved because they were most responsible for the management of the lake. The respondents were in five categories: 20 farmers, 20 pastoralists, 10 loggers, who were randomly selected from sample villages, while 5 village leader's, one from

each village, 3natural resources managers, and 7 fishermen were purposefully selected. Data were collected using documentary methods, personal interviews with key informants, Focus Group Discussions, observation, physical measurement, and administration of a questionnaire.

Both primary and secondary data were collected. The primary data concerned the awareness of Lake Rukwa resource users on the impacts of their activities, as well as the extent to which human forces contributed to the depletion of Lake Rukwa wetlands. Physical measurement of the shrinkage of the lake was made as well as the observation of activities in the wetlands and wetland destruction. Documentary method was employed to collect secondary data particularly, reports on the changes in lake depth and the management of lake Rukwa basin.

The primary data were collected through personal interviews held with key informants, such as Local Government Leaders, Natural Resources Officers and the elderly who live close to Lake Rukwa. They provided their views on the extent to which human forces contributed to the depletion of Lake Rukwa wetlands; whether people using the wetlands were aware of the impacts of their activities on the wetlands; and finally suggested measures for the sustainable use of Lake Rukwa resources.

Focus Group Discussions (FGDs) involving respondents from clusters of crop cultivators, agro-pastoralists and loggers were conducted in order to find out their perceptions and attitudes, on the awareness of the impacts of their activities on the well being of Lake Rukwa resources. Each group was composed of 6 participants.

Observation and photographing was done to depict the kind of activities performed along the lake and on how those activities affected the wetlands of Lake Rukwa. The interest was to see areas which were formerly below water, areas which were covered by wetlands in the past, how people were cultivating and grazing their herds along the lake, signs of soil erosion and lake siltation. Based on current and past lake levels, the researchers measured the extent to which the lake had shrunk and lost its wetlands. This was done with the assistance of the elderly key informants who were aged 70 years and above who showed where the lake extended in the past.

Secondary data were collected from official written documents available in offices such as booklets, administrative files and reports on Lake Rukwa conservation. Focus was on reports showing the changes in the size of the lake and its wetlands from the 1950s to the present.

Data analysis and interpretation went concurrently with data gathering, and report writing. Key informants, who had lived in the basin since 1970s, helped to provide information on changes of wetlands along Lake Rukwa from the past to the time of the research. Photographs taken in the study area facilitated statement of valid conclusions with regard to loss of wetlands, and shrinkage of Lake Rukwa. The changes in lake depth were established based on documentary data obtained from the department of natural resources of Sumbawanga district.

PRESENTATION OF RESULTS

Respondents' socio- economic characteristics

The age, gender, Education level and occupation of respondents influences how they exploit natural resources. Table 1 shows that majority of respondents were aged between 30-59 (80.6%) years, which is a group of productive forces capable of engaging effectively in economic activities. The, crop cultivators, agro- pastoralists and loggers conducted their activities in Lake Rukwa wetlands causing their depletion. With regard to gender, majority (69.3%) of the respondents were male, while female were 30.7%. This could be because ownership of household property in these patriarchal communities is usually under the control of males.

Table 1: Age of respondents

Age		**Frequency**	**Percent**
Valid	Below 30	10	15.4
	30-39	20	30.8
	40-49	22	33.8
	50-59	10	15.4
	60+	3	4.6
	Total	**65**	**100.0**

Source: Field data

Education wise, majority of respondents had a low level of education. Less than half (44.6%) had attained primary education of not more than seven years, while the majority (46.2%) had no formal education at all. Only 9.2% had secondary level education and above. Thus majority of the respondents (90.8%) had a low level of education. This situation could lead to low acceptance and adherence to environmental laws, guidelines and regulations thereby, accelerating the rate of wetlands depletion around Lake Rukwa due to ignorance. This situation also made it difficult for natural resources managers to involve communities in the issue of Lake Rukwa conservation.

With regard to economic activities practiced, the findings indicated that majority in the study area (61.5%) were practicing mixed farming (Agro-pastoralism) followed by fishing (28.5%), logging (4%), business (3%), and 3% other activities. Since a substantial proportion of people in the study area were engaged in crop cultivation and livestock keeping, they had a significant impact on the depletion of Lake Rukwa wetlands.

Human activities and depletion of the wetlands of Lake Rukwa

Human forces are frequently condemned for causing land resources degradation. Analysis of the data collected using a questionnaire and through observation, revealed that farmers were chief agents of the depletion of wet lands around Lake Rukwa. It was established that, every peasant farmer used not less than seven acres of wetlands along the lake. Through this practice, farmers contributed to loss of wetlands by clearance of the vegetation during land preparation for cultivation. Cultivation in wetlands exposed them to excessive evaporation leaving them dry during the dry season. Since the farmers close to the wetlands grow rice which requires much water, when the former piece of wetland dries up, they continue to encroach on fresh wetlands towards the lake. This was contrary to the National Environmental Policy (1997) whose objective is to minimize encroachment on wetlands and improve their management and conservation.

Encroachment on wetlands leads to their depletion and soil erosion in the lake basin. Cultivation in the wetlands, loosens the soil causing it to be easily carried away by agents of erosion particularly water during the rainy season. The process causes silting of the lake thus reducing its

depth. In addition, Focus Group discussions reported that irrigation of paddy farms was also done along the rivers which feed Lake Rukwa. It was learned that farmers over- used the water from rivers leading to less water feeding the lake, thereby leading to continuous shrinkage of the lake.

The information given above testifies that crop cultivation engineered soil erosion which in turn impacted negatively on the wellbeing of Lake Rukwa itself and the wetlands. This entails that the destruction of wetlands and the lake were influenced by unsustainable human activities, which disregarded the set environmental regulations. The National Environmental Management Council (NEMC) of Tanzania directs that human activities should be done 60 meters away from the lake and 30 metres from rivers. Seemingly, this directive was not enforced in Lake Rukwa basin. This contradicted the environmental policy which aims at protecting water sources and catchment areas for their sustainable use.

Deforestation taking place in Lake Rukwa basin was also found to be behind the depletion of wetlands around the lake and the actual shrinkage of the lake. Lake Rukwa is naturally surrounded by various species of vegetation which act as a cover to preserve the wetland along the lake. When farmers establish new plots, they clear the vegetation. As a consequence, the wetlands have been decreasing in size over time as confirmed by one of the informants:

"We always clear the land before cultivating. Clearing the vegetation along the lake has brought a very great impact on the quality of Lake Rukwa and its wetlands because the land along the lake which used to be always wet, it is now dry. The breeding grounds for fish have also been destroyed such that fish catches have declined".

These views entail that human activities along the lake apart from depleting the wetlands and the lake itself, had also affected food security and income from fishing.

Generally, cultivation along the lake was found to have significant negative impacts on the wetlands. The study area was estimated to have 500 farmers who cultivated the wetlands of Lake Rukwa (Ward Executive Office) unsustainably. If this trend of invading the wetlands persists, the wetlands of Lake Rukwa will vanish and soon the lake itself will disappear. This will be a great failure towards the attainment of the Sustainable Global Development Goals particularly goals; 6, 12 and 15. National efforts should strive to achieve goal 6 which aims at

ensuring availability and sustainable management of water and sanitation for all. The rivers found in the Lake Rukwa basin need to be well managed. There is also need to ensure sustainable consumption and production patterns (goal 12). More still, goal 15 aims to protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification and reverse land degradation and halt biodiversity loss (ISDG). All in all, the government of Tanzania needs to increase efforts towards the implementation of the Convention on Biological diversity.

Pastoralism and the depletion of wetlands of Lake Rukwa

Apart from crop cultivation, the pastoral activity was also a major agent for the depletion of Lake Rukwa wetlands. Large herds of cattle were observed grazing on green pasture along the lake during the dry season when the Rukwa basin is very hot and dry. It was observed that large herds tended to eat all grass and destroy other types of vegetation, leaving the wetlands bare. This in turn facilitated soil erosion and hence land degradation. Plate 1 testifies this assertion.

Plate 1: A herd of cattle and the degraded part of wetlands along Lake Rukwa

Source: Field data, September 2015

When the wetlands are devoid of vegetative cover, they lose their wetness through excessive evaporation. The study area was estimated to have more than 5,000 cattle which feed in the wetlands. Thus, if constructive remedial measures are not taken, the destruction of wetlands will continue.

Loggers and the depletion of Lake Rukwa wetlands

Deforestation in Lake Rukwa basin was another environmental problem identified in the study area. Due to high human population, there was a great demand for timber, wood fuel, pastures, expansion of farmland and settlements. All these entail felling of trees. Three decades ago Lake Rukwa basin had a thick forest dominated by huge acacia and brachystigea (Miombo) trees. However, owing to the influx of immigrants from various parts of the country to the basin especially the Sukuma agro-pastoralists, the area has changed to semi-arid as a result of massive deforestation. The remaining vegetation in Lake Rukwa basin is now dominated by scrubs and bushes (see Plate 2).

Plate 2: Part of a Deforested wetland near Lake Rukwa

Source: Field survey

Deforestation in Lake Rukwa basin has altered even the rainfall pattern that was experienced in the 1960s. Currently, the southern part of the basin receives on average, 650mm per annum while in the past it used to receive about 800mm. The shortage of precipitation has led to less water in rivers and streams which feed the lake thus causing the lake to shrink in size. Some rivers such as Momba and Songwe have almost dried up due to the deforestation done along their banks. Moreover, the affected rivers have changed their profiles and siltation has raised their river beds (see Plate 3).

Plate 3: Silted Momba river entering into Lake Rukwa. **Source**: field survey

The photo above shows part of river Momba that has been degraded throughout its course carrying massive sand and depositing it into Lake Rukwa

These, unsustainable production practices in Lake Rukwa basin entail that the concerned national institutions are weak in implementing environmental policies, and environmental guidelines.

Fishing activity and wetlands depletion

With regard to fisheries, the findings indicated that, fishing did not influence the depletion of Lake Rukwa wetlands. In contrast, the changes in the width and depth of the Lake had made the fishing activity to decline significantly. Grazing and cultivation along the lake, had led to noticeable destruction of the breeding grounds for fish. Consequently, the fish catches from Lake Rukwa had declined, impacting negatively on the income of fishers. This was testified by one fisherman during the focus group discussion thus:

"I have been here fishing for 25 years now. As people continue to farm and graze livestock in the wetlands, the lake continues to shrink. These activities have destroyed even the breeding areas for fish. We are not getting much fish as in the past and some fish species have already become extinct due to unfavorable environment. Therefore, this occupation is no longer paying".

Some species such as Hydrocynus vittatus (Kachinga) and Amphilus uranoscopus (Poloko) (in brackets are local names) were reported to have become extinct since the late 1990s. This extinction resulted from the alteration of the natural geomorphologic makeup of the lake, the

disappearance of wetlands and overexploitation. As a result, the common species found in Lake Rukwa are cat fish and tilapia although their availability and quality had declined. Consequently, the livelihoods of fishers have been negatively affected.

The Influence of human activities on the changes in depth and width of Lake Rukwa

With regard to changes in the depth of Lake Rukwa, data were collected through interview of the key informants, observation, physical measurement and documentation. Findings revealed that the depth of the lake had decreased significantly due to the impact of cultivation, grazing and logging along the lake. These anthropogenic activities were causing soil erosion and ultimately, siltation of the lake. About ten years ago, the part of Lake Rukwa shown on Plate 4, was deep enough. Now (2017) a person can walk on the deposited sand and silts that cover the bed of the lake.

Plate 4: Part of Lake Rukwa that is drying out due to siltation. **Source:** Field survey

Such siltation had already caused the depth of the lake to change from 12m to 5m as testified by one officer from the department of natural resources:

"One of the notable changes in Lake Rukwa is the decrease in its depth due to siltation. The lake used to have a maximum depth of 10-12 meters; today it is 5-8 meters".

This was further confirmed by satellite images given in Plate 5.

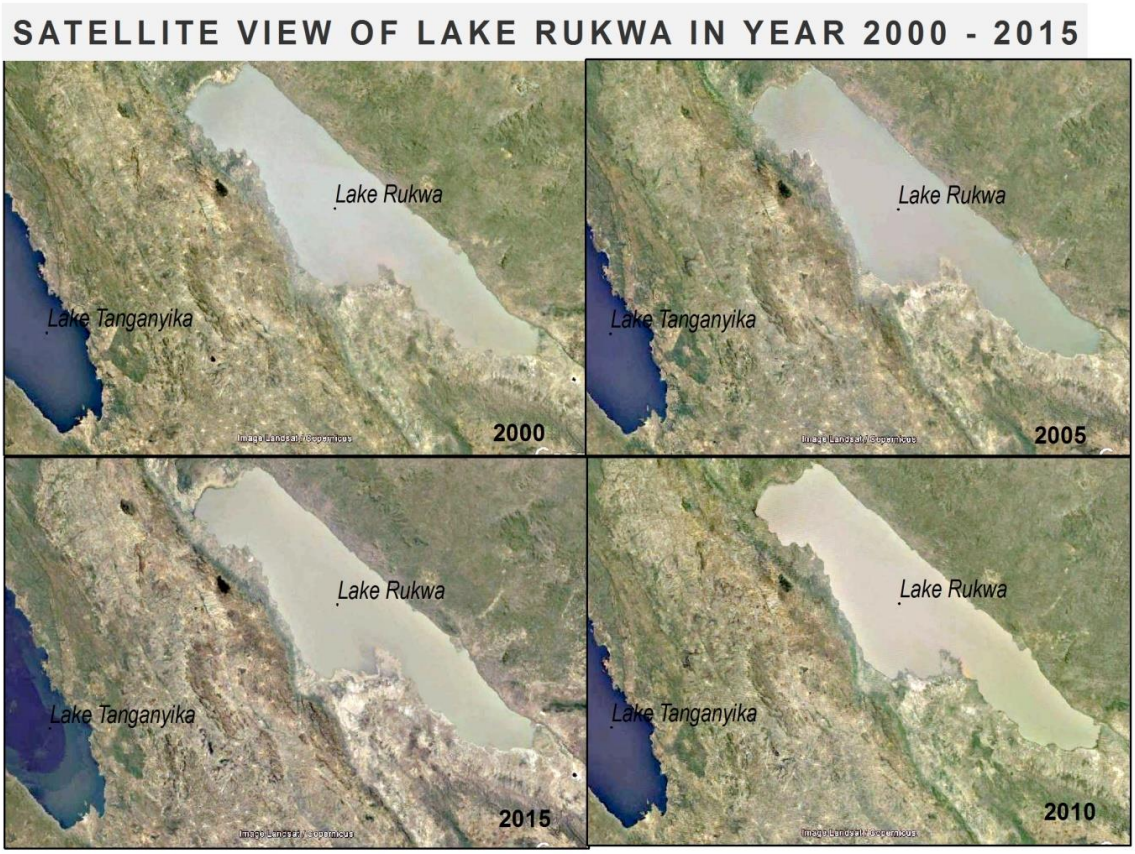

Plate 5: Changes in width of Lake Rukwa from 2000-2015**. Source:** Google earth

Note: The light colour of Lake Rukwa especially in 2010 is an indication of shallowness

Changes in the width of Lake Rukwa

Anthropogenic activities practiced along the lake shore have significant negative impacts on the size of Lake Rukwa. The width of the lake is continuously decreasing because of over utilization of the wetlands along the lake as explained in the preceding sections. Through field observation, the researchers had seen the margin of the lake a few years ago and found that the lake was rapidly shrinking. Also, the elders in the study area, helped to show the point where the lake extended in the 1990s. Measurement of exposed dry land done by the researchers indicated that, about 1.8kms which were formerly covered by the lake had dried up since the 1990s mainly because of paddy cultivation and livestock grazing. The Sukuma agro-pastoralists who have migrated into the area since the 1970s, own on average, 100 cattle per house hold. These have markedly, degraded the environment as shown on Plate 6.

Plate 6. Dry land resulting from the shrinkage of Lake Rukwa. **Source:** Field survey

At the back ground is the lake, in front is land that was part of the lake in 1998. It is now used as grazing ground. See the overgrazed land.

Plate 7 below shows part of Lake Rukwa that has become dry five years ago. This part was covered by water in the 2000s. One of the natural resources officers said the following on this aspect:

Approximately, 2kilometers of wetlands around Lake Rukwa have dried out during the past ten years.

This information entails that the degradation of Lake Rukwa and its wetlands is more rapid than before. Thus, strategies for restoring the lake and its resources should be implemented quickly.

Plate 7. Part of Lake Rukwa, that has dried out. See the exposed bare rocks. **Source**: Field survey

4.4 The awareness of people on the impacts of human activities on the wetlands of Lake Rukwa.

Regarding the awareness of users of the Lake Rukwa wetlands about the impacts of their activities on the wetlands, data revealed that, only few wetland users were aware of the impacts of their activities, on the sustainability of the wetlands. Some wetland users were completely unaware of their impacts on the sustainability of the lake. This group believed that the wetlands were not affected by human activities. Rather, natural forces such as drought altered the wetlands. One respondent from village A had this to say during the discussion:

"I don't think that human forces can damage the huge water body like a lake. What I know is that, activities like grazing along the wetlands can be done year after year without any negative effects on the lake. I agree that the size of wetlands is decreasing these days compared to some years back, and the major cause of this trend is unreliable rainfall".

On the same idea, another informant with more than secondary education commented the following during an interview session:

Many people are not aware of the impacts their activities have, on wetlands along the lake. This problem has brought several conflicts between agro pastoralists and the natural resources managers who try to restrict them to farm and graze near the lake shore. People consider that to stop those practicing agricultural activities along the lake is a violation of human rights and it is unfair. Thus, they end up protesting.

The issue of low awareness of wetland users on the impacts of their activities was also reported by the natural resources officer as a big challenge for conserving Lake Rukwa.

The level of education influences ones awareness about forces that destroy the environment and hence the readiness to conserve it. Since most of the users of the lake resources had low education, they thought that they could exploit the natural resources endlessly.

Nonetheless, there were few users of Lake Rukwa who were aware of the impacts of human activities on the wetlands of the lake. However, they were obliged to continue degrading the wetlands due to lack of alternative means of livelihood open to them. One of the respondents wrote the following in the questionnaire:

"I know that pastoral activities have damaged the wetlands to a large extent in Lake Rukwa basin. Due to shortage of green pastures during the dry season many pastoralists have settled close to wetlands with their large herds of cattle. This is because, the large part of Lake Rukwa basin that is suitable for grazing is within the Uwanda game reserve where human activities are prohibited. This situation has led to overgrazing and depletion of Lake Rukwa wetlands".

The above explanation reveals that large herds in face of shortage of grazing land, have forced pastoralists to graze their livestock in prohibited areas. On the same idea, a crop cultivator in a Focus Group Discussion said:

"I know that cultivating along the lake depletes the wetlands of the lake. We are attracted to cultivate along the lake shore because the land is fertile, it gives us high yields of rice. We deplete the wetlands because we are facing the problem of shortage of arable land."

Shortage of land and improved agricultural practices were unmet needs which the government was supposed to work on. The foregoing statements entail that, some people were aware of the negative impacts of their activities on the wetlands. However, they were obliged to encroach on

them for lack of alternative means of subsistence. Hence, there was a need to improve and diversify production practices to help peasants make a living instead of depending solely, on the productivity of natural resources.

Conclusion

The study aimed at assessing the impacts of human forces on the status of Lake Rukwa wetlands in Sumbawanga district. The results have shown that, human activities in Lake Rukwa wetlands have significantly affected their sustainable existence. Cultivation, grazing, and deforestation along the lake, had significantly contributed to the depletion of the wetlands over time. In turn, improper management of the lake resources had accelerated the resource ride. Large herds of cattle were freely grazing in the wetlands. Cultivation was also done freely in the wetlands throughout the year. The findings confirmed that, human activities particularly, paddy cultivation and livestock grazing had significantly led to the depletion of the wetlands along Lake Rukwa. The same activities together with logging had caused massive soil erosion and siltation of the lake, leading to the reduction of its depth and width. In turn, the disappearance of wetlands and the shallowness of the lake had destroyed fish breeding areas leading to low fish catches. Consequently, fishers' income has declined leading to their impoverishment. The utilization of Lake Rukwa wetlands was done without proper enforcement of the wetlands conservation guidelines.

Despite the degradation of the wetlands and the lake itself, many people who were exploiting the Lake Rukwa resources were ignorant of the negative impacts of their activities on the wetlands and the lake. This means that, many wetland users were not aware that they were destroying the very base of their subsistence. The few who were aware of their negative impacts on the sustainability of the wetlands, continued to encroach on the wetlands due to lack of alternative means of livelihood.

Based on the results, it was recommended that the natural resources managers should raise the awareness of the people by educating them on sustainable practices of using wetlands of Lake Rukwa. The community participatory approach, was recommended to ensure proper wetland use and conservation. Also, the government officials should control and monitor the use of the

wetlands, rivers and forests in Lake Rukwa basin according to the set laws, guidelines and enforcing the integrated resource management plan for Lake Rukwa basin.

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