International Journal of Research in Engineering and Science (IJRES)
ISSN (Online): 2320-9364, ISSN (Print): 2320-9356
www.ijres.org Volume 11 Issue 1 ǁ January 2023 ǁ PP. 354-359

Socio-Ecological Drivers and Dynamics of *Limnothrissa Miodon* on Lake Tanganyika: A Case of Mpulungu District

George Kambonge*[1], Liberty Mweemba[1]
[*1]*Department of Geography and Environmental Studies, University of Zambia, Lusaka, Zambia*
**Corresponding Author's email address: onekambongegeorge@gmail.com*

Abstract
Socio-ecological systems as well as integrated complex systems include social which is the human aspect and ecological which is the biophysical subsystem that is in a two-way feedback relationship. Systems outputs are returned to structure as an input either to oppose the initial input which is the negative feedback or, to enhance it which is the positive feedback. This relationship occurs whenever people interact with their environment. Forms of interactions can vary from community-based small-scale fishing to country-wide eco-tourism. Thus, interactions within a socio-ecological system have implications regarding social systems, for instance, jobs and ecological systemsin this case, biodiversity loss. Social phenomena such as poverty, economic opportunities and identity can interact with ecosystem dynamics in mutually reinforcing ways generating vulnerable pathways of development and undesirable states highly resilient to change. Human actions affect feedback and drivers in socio-ecological systems which may lead to regime changes. Such changes adjust ecosystems capacity to generate services on which humans depend on in turn trigger societal responses. Recognition of such interactions reveals that dynamics of social and ecological systems are inextricably linked. A socio-ecological system describes dynamics and interactions between society and ecosystems through social, economic and ecological processes that influence the state of natural resources. This studyrecommended numerous regulatory actions made in this article to control indiscriminate fishing. These strategies comprised fishing quotas, bag limits, fisher licensing, closed seasons, size limits, aquaculture practices, creation of freshwater reserves and freshwater protected areas.

Key words: *Socio-ecological, Drivers, Dynamics, Limnothrissa miodon, Lake Tanganyika.*

Date of Submission: 11-01-2023 Date of acceptance: 27-01-2023

I. INTRODUCTION

Profitable Kapenta fishing on Lake Tanganyika is no longer taking place (Sipula,2021; Murimwa, 2020; Chitalu, 2018; Zambia Farmers Hub, 2017; Department of Fisheries, 2014; Dube and Chiwanga, 2014; The New Humanitarian, 2009). Furthermore, it can also then be noted that commercial Kapenta fishing companies on Lake Tanganyika have now resorted to purchasing the *Limnothrissa miodon* commodity from semi-industrial fishers then process and package it in readiness to markets (Department of Fisheries, 2014; Marcel, 2018; World Bank, 2018; National Assembly of Zambia, 2021).Therefore, biomass reduction of *Limnothrissa miodon* if not checked on Lake Tanganyika exacerbate employment shortages and income generation setbacks for the local people, exacerbate the unavailability of food and nutritional security and also foster the local people to divert to other livelihoods such as charcoal production which exacerbate effects of climate change. It is worthy it then to note that this studyexamined Socio-ecological Drivers and Dynamics of *Limnothrissa miodon* on Lake Tanganyika and provided strategies to sustain the resource on the lake.

1.1Objectives of the Study

The study was guided by the following objectives;

i. to establish factors of biomass reduction of *Limnothrissa miodon.*
ii. to investigate effects of not sustaining *Limnothrissa miodon* on fishers and marketeers.
iii. to suggest strategies that could be used to sustain *Limnothrissa miodon*.

II. MATERIALS AND METHODS

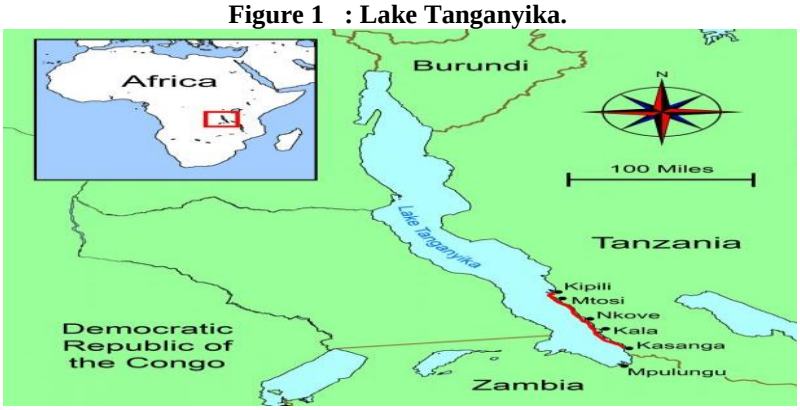
To achieve objectives of the study, the researchwas conducted in Mpulungu District along the bank of Lake Tanganyika with a sample size of one hundred and twenty four (124) respondents. These respondents were taken from Musende, Kasasa and Kabatwe fishing villages and Ngwenyemarket in the district. This study used a

case study research design and qualitative method was used to capture attitudes, views, ideas and opinions of respondents (Bryman, 2014; Yin, 2014). The study employed a single case study strategy whose purpose comprehended with the importance of singularity by investigating the opinion of people who have vast knowledge on drivers that influence the decline of *Limnothrissa miodon*(Syabwanta, 2019).

2.1 Study Area

The study was conducted on Lake Tanganyika in Mpulungu District and species of fish in question is endemic to the lake. Lake Tanganyika stretches by and large north to south orientation amid narrow boundaries of the steep eastern and western escarpments of the Western Rift Valley from 03°20' S to 08°48' S latitude and 29° 03' E to 31° 12'E longitude. On the other hand, fisheries resources on Lake Tanganyika play a significant role in the economy, people's welfare and diet in riparian states which include Zambia, The Democratic Republic of Congo (DRC), Burundi and the United Republic of Tanzania (URT). Individuals in these countries share the lake's watershed and depend on Tanganyika for freshwater, food, transportation and income (The New Humanitarian, 2009). Figure 1 show the geographical location of the studyarea.

Figure 1 : Lake Tanganyika.



Source : Small Boats Magazine.

2.2 Data Collection

Data collection was conducted through the issuance of questionnaires to fishers and marketeers. Semi-structured interviews were conducted with key informants, therefore, the study targeted fishers, marketeers and key informants (Syabwanta, 2019). Selection of entities was founded on an individual judgment rather than randomization (Elder, 2009). Convenient sampling was used to collect relevant data at expedient times and was dependent on accessibility of fishers in fishing villages and marketeers as they sell *Limnothrissa miodon* in the market (Syabwanta, 2019). Areas in the fishing villages that were difficult to sample when using other sampling methods were reached assamples had traits that were rare to find. The sub-group of the population wereselected based on snowball sampling, convenient sampling and expert purposive sampling. The small number of individuals from the whole population was selected to represent a large group of the population. Subjects meriting the capacity to provide important data were chosen on purpose. Specific respondents the researcher believed would give most valuable information were selected for interviews. The retired fisheries staff hailing from Mpulungu District directed the researcher to respondents that provided the most important data and eventually the researcher interviewed respondents he easily accessed from the larger population.

III. RESULTS

3.1 Drivers that Contribute to Decline of *Limnothrissa miodon*

There are a number of drivers that contribute to biomass reduction of *Limnothrissa miodon* on Lake Tanganyika. Drivers that contribute todecline of *Limnothrissa miodon* are presented in figure2.

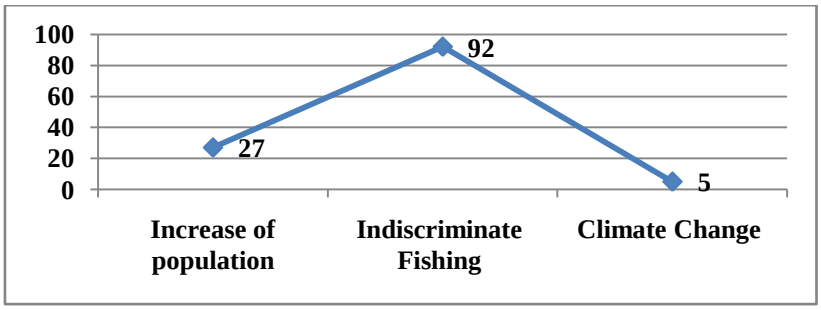


Figure 2: Drivers of Biomass Reduction of Kapenta
Source: Field Data - May, 2021.

In figure 2, twenty two percent (22%)attributedincreased population of fishers and marketeers to biomass reduction of *Limnothrissa miodon;* seventy fourpercent (74%) attributed indiscriminate fishing to biomass reduction of *Limnothrissa miodon* and four percent (4%) attributed climate change to biomass reduction of *Limnothrissa miodon.*

3.2 Effects of not Sustaining *Limnothrissa miodon*

Kapenta fishing is a source of food, employment and/or business to fishers as well as marketeers and its sustainability is hampered by a number of challenges that leads to effects. Figure3 indicate effects of not sustaining *Limnothrissa miodon.*

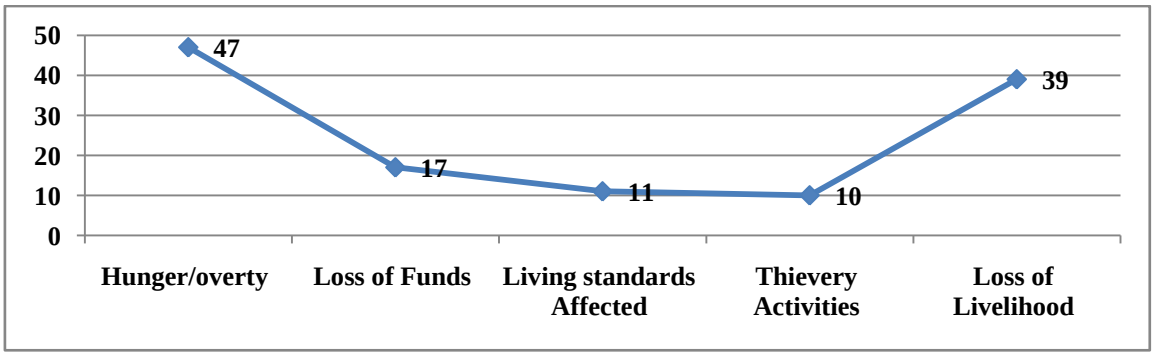


Figure 3: Effects of Decline of Kapenta
Source: Field Data - May, 2021.

Figure 3 showthirty eight percent (38%)that said hunger/poverty affected them due to declined levels of *Limnothrissa miodon;* fourteen percent (14%) said there was loss of funds due to decline of *Limnothrissa miodon;* nine percent (9%) said standards of living were affected due to decline of *Limnothrissa miodon;* eight percent (8%) said there were too many thievery activities taking place in the area due to declined levels of *Limnothrissa miodon;* thirty one percent (31%) said there was loss of livelihood due to decline of *Limnothrissa miodon.*

3.3 Strategies to Sustain *Limnothrissa miodon*

Decline of Kapenta has been observed on Lake Tanganyika, therefore, fishers and marketeers had suggested strategies that maybe used to sustain the resource.Findings are presented in figure 4.

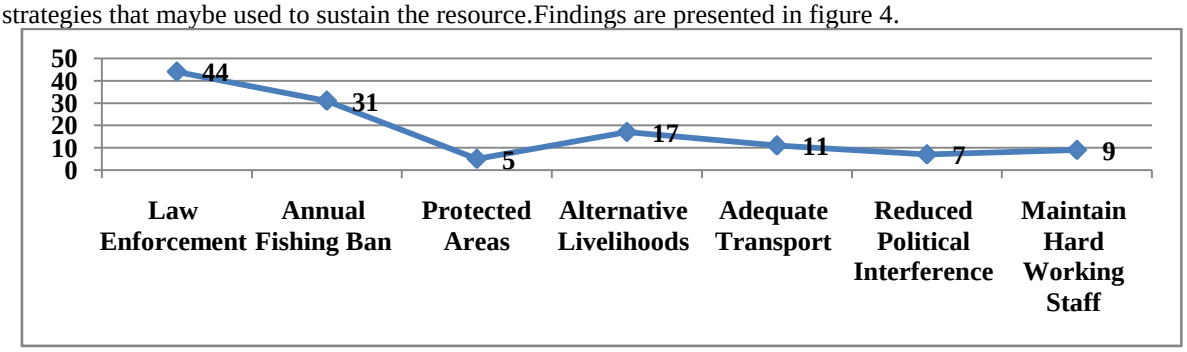


Figure 4: Strategies to Sustain Kapenta
Source: Field Data – 2021

In figure 4, thirty five percent (35%)preferred law enforcement by Department of Fisheries with other agencies to sustain *Limnothrissa miodon;*twenty five percent (25%) needed introduction of annual fishing ban on the lake to sustain *Limnothrissa miodon;*four percent (4%) needed freshwater protected areas to sustain *Limnothrissa miodon;* fourteen percent (14%) needed alternative livelihoods to sustain *Limnothrissa miodon;*nine percent (9%) asked for adequate transport for fisheries staff for operations tosustain *Limnothrissa miodon;* six percent (6%) needed reduced political interference on affairs of the lake to sustain *Limnothrissa miodon* and seven percent (7%) needed hard working staff in law enforcement operations to be maintained and/or retained within the district so Kapenta can be sustained.

IV. RESULTS AND DISCUSSIONS

4.1.1 Indiscriminate Fishing

Results showed indiscriminate fishing as a major driver that contribute to biomass reduction of *Limnothrissa miodon* on Lake Tanganyika. In figure 2, ninety two (92) respondents attributed indiscriminate fishing to biomass reduction of *Limnothrissa miodon*. Indiscriminate fishing is the key driver that contribute to biomass reduction of *Limnothrissa miodon*. Indiscriminate fishing as a driver that contribute to biomass reduction of *Limnothrissa miodon* is in line with Bustamante et al (2018) who reported; overharvestingor, overexploitation takes place when humans harvest extra of a natural resource than it can replenish on its own.Bustamante et al (2018) further said, this unsound activity threatens living organisms and can damage ecosystem services by plummeting species population below natural self-sufficient levels and unsettling ecosystem functions and species interconnection. Wana (2016) agreed; definitely, countless experts have the same opinion that the utilization limit of marine resources have been reached if not exceeded and that congestion of fleets, extreme fishing quotas, illegal fishing activities and by and large, pitiable management of majority of fisheries resources are to blame.

4.1.2 Increase in Population of Fishers and Marketeers

Increase in population of fishers and marketeers aredrivers that contribute to biomass reduction of *Limnothrissa miodon* as seen in figure 2. Twenty seven (27) respondents attributed increase in population of fishers and marketers to biomass reduction of *Limnothrissa miodon.*Increase in population of fishers and marketeers as a driver that contribute to biomass reduction of *Limnothrissa miodon* was agreed upon by Bustamante et al(2018) who said; capture fisheries equally are undergoing various challenges from anthropogenic activities, namely, population growth, habitat destruction, pollution, invasive species introduction, overfishing and climate change. Increase in population of fishers and marketeers was also agreed upon by Wana (2016) who lamented that overfishing exhibited severe risks as integration of marine natural diversity can have severe outcomes for the control of marine and coastal ecosystems.

4.1.3 Climate Change

In figure 2,five (5) respondents attributed climate change to biomass reduction of *Limnothrissa miodon*. Findings on climate change as a driver that contribute to biomass reduction of *Limnothrissa miodon* are in line with Wana (2016) who reported that climate change exhibit noteworthy intimidation to fisheries in addition to countless other simultaneous pressure. Wana (2016) further added; climate change is impacting a variety of biotic elements that are firmly connected to production and distribution of fish species population and these climate-driven biotic changes will probably be different amid open ocean, shelf seas and coastal waters. Medhi et al (2018) concurred with Wana (2016) and they alluded; climate change is contributing to problems of inland fisheries population instability.

4.2 Effects of not Sustaining *Limnothrissa miodon*

Figure 3 showed effects of decline of Kapenta. Forty seven (47) respondents said hunger/poverty affected them due todeclined levels of *Limnothrissa miodon;* thirty nine (39) respondents said there was loss of livelihood in the area due to decline of *Limnothrissa miodon;* seventeen (17) respondents said there was loss of funds due to decline of *Limnothrissa miodon;* eleven (11) respondents said standards of living were affected due to decline of *Limnothrissa miodon;* ten (10) respondents said there were too many thievery activities in the area due to decline of *Limnothrissa miodon.*

Effects of not sustaining *Limnothrissa miodon* mentioned in the study area are supported by Coll et al (2008) who said; unstable population growth exacerbate poverty in small coastal communities and developing nations by increasing pressure on local resources. Coll et al (2008) further added, ultimately, this negatively affects local economies because they overexploit already vulnerable and top-predator fish stocks resulting in issues of food scarcity and loss of livelihood in future. Jones (2013) also concurred with Coll et al (2008) who added; fish are what are known as common-pool resources, as a result, poverty increases as they are overharvested.

4.3 Strategies to Sustain *Limnothrissa miodon*

Figure 4 indicate forty four (44)respondents that preferred law enforcement by Department of Fisheries with other agencies to sustain *Limnothrissa miodon;*thirty one (31) respondents needed introduction of annual fishing ban on the lake to sustain *Limnothrissa miodon;*five (5) respondents needed freshwater protected areas to sustain *Limnothrissa miodon;*seventeen (17) respondentsneeded alternative livelihoods to sustain *Limnothrissa miodon;*eleven (11) respondents asked for adequate transport for fisheries staff for operations to sustain *Limnothrissa miodon;* seven (7) respondents needed reduced political interference on affairs of the lake to sustain *Limnothrissa miodon* and nine (9) respondents needed hard working staff in law enforcement operations to be maintained and/or retained within the district so Kapenta can be sustained.

Strategies explained by respondents in the study were supported by Tursi et al (2015) who said; to reach Good Environmental Status, each member state surrounding Lake Tanganyika have to develop a freshwater strategy which must be agreed upon with all neighboring member states. Huang and He (2019) concurred with Tursi et al (2015) and said; annual fishing ban and suspension of freshwater fishing activities must be fully adopted on the lake to save natural resources. Njiru et al (2017) also alluded; Government of the Republic of Zambia should change management strategies and bring in stakeholders through community involvement on Lake Tanganyika by forming Beach Management Units (BMUs).Winder (2018) also concurred with Njiru et al (2017) who said,a more deep-seated option is to declare definite locations of the lake "no-go areas" and make fishing in such locations rigorously unlawful so fish in such places can have time to improve and repopulate.

V. CONCLUSIONS

Socio-ecological drivers that contribute to biomass reduction of *Limnothrissa miodon* include indiscriminate fishing, increase in population of fishers and marketeers and climate change. Then again causes of biomass reduction of *Limnothrissa miodon* include wrong fishing methods and illegal fishing gears, rapid population growth, advanced fishing technologies, political interference, harvesting of *Limnothrissa miodon* in breeding areas, nature of Lake Tanganyika, reduced policies and patrols, God's will and lack of manpower. Available proof recognize that regions without assessment of large quantities of fish have minute fisheries management and fisheries resources are in a poor profile (Thurstan et al., 2010). Low resources management loads has a negative effect; that is the sustainable yield of fish is lower so fisheries resources contribute less to food production and the cost of harvesting resources often rises when abundance is low (Hilborn et al.,2019). Humans harvesting fish results in far greater consequences of fish depletion than other natural causes with enormous potential affecting phenotypic traits of fish population even after exploitation of fisheries resources is stopped (Pandolfi, 2009).Admittedly, there is an evidence of increased harvest pressure which is as a result of increased harvest efficiency and increased resource demand. Further, there is also an intensified harvest efficiency and decreased state of resources (Fauchald et al., 2017). Indisputably, sad realities of not protecting fish species in question has led to predicament of tragedy of the commons referred to in an article by Garrett Hardin that was initially published in the journal of Science (Hardin, 1968). Pivotal to Hardin's paper despite publishing it several decades ago is an instance which is a helpful story for understanding how decline of *Limnothrissa miodon* on Lake Tanganyika has occurred (Hardin, 1968).

Acknowledgements

I would like to convey my heartfelt appreciation to Dr. Mweemba Liberty my research supervisor for his closeas well asgenerous contributions in supervising the work and for rephrasing the research topic. Compilation of this dissertation is indebted much to those who wholeheartedly took their time and conceited efforts to offer the much appreciated criticisms and ideas on how dissertations and/or theses must be written.

REFERENCES

[1]. Bryman, A (2014) **"Social Research Methods"** 4th edition, Oxford USA http://www.academia.edu
[2]. Bustamante, M., Eileen, H., Schill, Helmer, S (2018) **"Indirect Drivers of Change in Biodiversity and Nature's Contributions to People"** Brazil http://www.data.fs.usda.gov
[3]. Chitalu, G(2018)**"Has Kapenta been Dethroned from our Menus?"**http://www.daily-mail.co.zm/has-kapenta-been-dethroned-from-our-menus/
[4]. Coll, M., Libralato, S., Tudela, S., Palomera, I., Pranovi, F (2008) **"Ecosystem Overfishing in the Ocean"** Barcelona, Spain 3 (12) pp. 1-10 http://www.plosone.org
[5]. Department of Fisheries (2014) **"Fisheries Statistics and Information Management Unit: 2014 Fisheries Statistics Annual Report"** http://www.zedbream.files.wordpress.com
[6]. Dube, V and Chiwanga, S (2014)**"Zimbabwe vs. Zambia Kapenta Fish War Turns Ugly"**https://nehandaradio.com/2014/08/17/zimbabwe-vs-zambia-kapenta-fish-war-turns-ugly/
[7]. Elder, S (2009) **"Sampling Methodology ILO School-to-work Transition Survey: A Methodological Guide Module 3"**www.ilo.org/publns
[8]. Fauchald, P., Hausner, V. H., Schmidt, J. I., Clark, D. A (2017) **"Transitions of Social-ecological Subsistence Systems in the Arctic"** International Journal of the Commons Norway Vol. 11, no 1 pp. 275–329 http://www.thecommonsjournal.org

[9]. Hardin, G (1968) **"Tragedy of the Commons"** Science. United Kingdom Vol. 162, Issue 3859 pp. 1243-1248 http://science.science.mag.org

[10]. Hilborn, R., Amorosoa, R. O., Christopher M. Andersona, Julia K. Baumb, Trevor A. Brancha, Costelloc, C., Carryn L., Moord, d., Faraje A., Hivelya, D., Jensenf, O., Kurotag, H., Richard L., Macei P., McClanahanj, T., C. Melnychuka, M. C., Mintok, C., Osiol, M. G. C, Ana M., Ponsa P. M., Seguradoo S, Cody S., Jono, S. C. R., Wilson, and Ye, Y (2019) **"Effective Fisheries Management Instrumental in Improving Fish Stock Status"** University of Oslo, Norway pp. 2218–2224 http://www.pnas.org

[11]. Huang, S., He, Y (2019) **"Management of China's Capture Fisheries: Review and Prospect" College of Marine Culture and Law"** Shanghai Ocean University China pp. 173–182http://www.keaipublishing.com

[12]. Jones, E (2013) **"The Environmental and Socio-economic Effects of Overfishing Due to the Globalization of the Seafood Industry"** Thailand pp. 1-20 http://www.docplayer.com.br

[13]. Marcel, S (2018) **"Determination of Crude Protein in Limnothrissa miodonin Lake Kivu".** Chem Sci J 9: 194 University of Rwanda, Rwanda http://www.researchgate.net

[14]. Medhi K., Tapas, P., Borah, A. K., Bhattacharjya, B. K., Debnath, D., Yengkokpam, S., Kuberan, G (2018) **"Fish Stock Depletion in Indian Inland Open Waters: Present Status and Approaches for Sustainable use, Conservation and Management"** http://www.researchgate.net

[15]. Murimwa, C (2020) **"Kapenta crisis in Kariba Dam"** https://businesstimes.co.zw/kapenta-crisis-in-kariba-dam/

[16]. National Assembly of Zambia (2021) **"Committee on Agriculture, Lands and Natural Resources for the Fifth Session of the Twelfth National Assembly"** https://www.parliament.gov.zm

[17]. Njiru J., Waithaka, E., Peninah, A., Aloo (2017) **"An Overview of the Current Status of Lake Naivasha Fishery: Challenges and Management Strategies"** The Open Fish Science Journal Mombasa, Kenya pp. 1-10 http://www.benthamopen.com

[18]. Pandolfi, J. M. J (2009) **"Evolutionary Impacts of Fishing: Overfishing's 'Darwinian Debt"** University of Queensland, Brisbane, Australia pp. 1-3 http://www.F1000.com

[19]. Sipula, C (2021) **"Tanganyika Fish Stock Decline under Spotlight"** http://www.times.co.zm/?p=110193

[20]. Syabwanta, S (2019)**"A Proposed Climate Change Education Programme for Sinazongwe District of Southern Zambia"** https://dspace.unza.zm

[21]. The New Humanitarian (2009) **"Zambia: Mosquito-net Fishing Threatens Lake Tanganyika"**https://reliefweb.int/report/burundi/zambia-mosquito-net-fishing-threatens-lake-tanganyika

[22]. Tursi A, Sion P. M. L., D'onghia, G (2015) **"Fishery Resources: Between Ecology and Economy"** 26: pp. 73–79 University of Bari Aldo Moro, Bari, Italy http://www.pringerlink.com

[23]. Thurstan, Ruth H., Brockington S., Callum M., Roberts (2010) **"The Effects of 118 Years of Industrial Fishing on UK Bottom Trawl Fisheries"** Nature Communications United Kingdom pp. 1-15 http://www.nature.com

Wana, T. G (2016) **"A Review on the Causes for the Loss of Major Fishes and Prospects for Future Research in Ethiopia"** Hawassa Ethiopiahttp://www.researchgate.net

[24]. Winder, G. M (2018) **"Fisheries, Quota Management and Quota Transfer: Rationalization through Bio-economics"** Mare Publication Series Berlin Volume 15 http://www.springer.com

[25]. World Bank (2018) **"Project Information Document/Integrated Safeguards Data Sheet"** Lake Tanganyika Environmental Management Project pp. 1-21 http://www.documents.worldbank.org

[26]. Yin, R. K (2014)**"Case Study Research Design"** https://www.researchgate.net

[27]. Zambia Farmers Hub (2017) **"Sardines (Kapenta) at Risk of Extinction in the Kariba Dam"**https://zambiafarmershub.wordpress.com/2017/06/15/sardines-kapenta-at-risk-ofextinction-in-the-kariba-dam