

INFLUENCE OF FISH FARMING ACTIVITIES ON ENVIRONMENTAL CONSERVATION: A CASE STUDY OF MNARANI NATURAL AQUARIUM, BARAKA NATURAL AQUARIUM, CHUMBE MARINE CONSERVATION AND ZANZIBAR MARINE SANCTUARY

Said Juma Ali, Dr. Kombo Hamad Kai

Jomo Kenyatta University of Agriculture and Technology, Kenya

Abstract: Fish farming normally known as aquaculture is mainly the commercial business of raising fish for human consumption; fish farming can be enclosed in marine or natural water or artificial water body during farming, and covered by the forest to minimize the external environmental stress such as salinity and temperature increase as well as human induced stresses. Though it raises the status of social economic livelihood activities, but fish farming industry is faced by number of harvesting threats including the use of illegal fishing gears, antibiotic for treatment and disposals which affects the environment and biodiversity of the farms. In this study the influence of fish farming activities to the environmental conservation of fish farms and marine protected areas was analyzed. Four study sites of Beit el Ras, Baraka, Chumbe and Mnarani were used, and questionnaire and interview approaches were used as data collecting tools. Both purposive and random sampling techniques were used to select 80 respondents over four selected study sites. The study used both the qualitative and quantitative approaches of data analysis where statistical variables such as sum mean and percentages were used to produce the results from the sorted interview and questionnaire responses. Excel work sheets were used for plotting different types of graphs. The results revealed that preparation of fish farms and marine protected areas have significant impact to the environment as supported by 81% of the respondents. Deforestation, destruction of mangroves which may result into coastal erosion was among the highlighted impacts. Moreover, the results revealed that fish farming was perceived as leisure and tourist activities but currently fish farming 19% of respondents were treating it as main socio economic activity. As for the influence of fishing gears (e.g. small to medium nets, Utupa among others) to the fish farms environment results revealed that small (33%) to medium nets (31%) have high impacts such as killing small fishes, eroding the farms and surroundings as well as taking out unwanted materials like shells, sea grasses among others. Besides, the study has shown that Baraka and Chumbe have high frequency of using medium and small nets. Also the study has found the existence of high fishing frequency per week which highly erode the marine protected areas as supported by questionnaires responses of 43%, 33% and 25% attended fishing twice, thrice and four times a week, respectively. Indeed the proper harvesting frequency of once a week (33%); twice a week (27%); once in two weeks (13%) and once a month (27%) was also high to a level of overfishing which is among the factors of environmental degradation. The restriction of popping unwanted materials (plastic bag among others), though the by laws are not being well practiced to punish the accused ones. Furthermore, the study has found that bombs and toxic gears (like chemicals, acids among others) which killed large number of fishes and disturbs the biodiversity are used. This was supported by 18%, and 74% of respondents were aware on the impacts of bombs to fishes environment and water quality. On the other hand the study has found the lack of proper monitoring education, technology and cooperation between fish farm owners and the society were among the challenges facing the pond and

marine protected areas. Thus the study conclude that fish farming activities ranged from preparation of fish farms, gears used during fishing, harvesting frequency and disposals of unwanted materials to the fish farms and marine protected areas severely affects the environments of the fish farms and their surrounding areas. Also the study recommends the extensive awareness and cooperation between the fish farms owners, local governments and the society in maintain the environment of fish farms and marine protected areas.

Keywords: Preparation of fish farm/ponds, Fishing by Small Net, Fishing using Bomb and Toxic Gears, Disposal and Antibiotics, Environmental Conservation.

1. INTRODUCTION

Fish farming normally known as aquaculture or pisciculture is mainly the commercial business of raising fish for human consumption, (Lorenzen *et al.*, 2013). In this process fish are grown in tanks, ponds, cages or irrigation ditches. In aquaculture not, only fish are raised but also, other aquatic organisms such as crustaceans and aquatic plants are also raised (Tanzania Fishery Sector, 2016). In an extensive fish farming, or off-shore (Marine culture) fish cultivation, fishes are kept inside enclosures of oceans and other natural or artificial water bodies, (Lorenzen *et al.*, 2013), where they are artificially fed in an efficient environment control measures to minimize fish stresses like diseases which may lead to low yields, (Beath *et al.*, 2009). The environmental stresses on fishes include, overfishing, fisheries management, by-catch and the methods or gears used in fishing such as small nets among (IUCN, 2017). The highlighted issues are among the important aspects of marine conservation systems. Due to environmental and human (i.e. the increased world population growth and their socio-economic demands) stresses on fishing, there always exists a growing gap between the supply and demand of fish in markets (Jones *et al.*, 2003). The conservation of the marine or aquatic areas includes the management of human exploited resources for current public benefit and sustainable socio-economic utilization (IUCN, 2017). Normally the marine fish farming is conducted on the strips, and conservation of these areas includes the proper management and sustainable usage of coastal features which includes the aspect of nourishment of beaches, hotels, restaurants, and roads, seawall construction, among others, (Ngungi *et al.*, 2007). Due to increased population over the coastal areas the coastal ecosystem becomes more vulnerable to environmental degradation of both marine reserves and coastal aquatic features (Edgar *et al.*, 2007).

The importance and scale of fish farming (aquaculture and Mari culture) varies from one country to another. For instance, the Small-Scale fishery (SSF) in Zanzibar had become a foundation of its economic development. Worldwide, the SSF employs and supports the livelihood and 35.5 million (Hastein *et al.*, 2006), whereas in Zanzibar the sector supports/employs 95,000 people i.e. 28% of the entire population, and most of these people live in the coastal areas (Coastal Profile for Zanzibar, 2014). Moreover, the SSF sector had contributed to about 7% and 7.1% of the Gross Domestic Product (GDP) in 2012, (RGoZ., 2014). As for the aquaculture or fish farming in Zanzibar, irrespective of being on its infancy stage (the revolutionary government of Zanzibar, 2014), but has got significant contribution to the socioeconomic activity of the coastal livelihood. It is estimated to contribute to about 1.5% of the GDP and approximately employs about 30,000 people (0.02% of the population).

Despite of its importance, this sector has got a lot of challenges including awareness (poor understanding) towards fish farming, traditional merits, inadequate resources (funds) for construction of fish farming ponds, and the environmental degradation of the few existing fish farming. Moreover, in efficient methods of fishing, such as the use of small nets, bombing and using toxic gears are among the issues of concern in small scale fishing industry. These fishing methods affects the coral reefs, (Eyo, 1995) hence affects the nursery grounds as well as killing the small fishes. This leads to, destroying the fishing grounds and in turn scarce in different types of fish leading to depressed livelihood of the coastal community. Thus, this study generally aims to investigate the influence of fish farming activities on environmental degradation using the observations, questionnaires and interviews on the selected case study sites of Chumbe, Beit el ras, Mnarani Natural Aquarium and Baraka Natural Aquarium, respectively.

2. PURPOSE

The purpose of the study was to analyze the extent to which fish farming affects the environmental conservation and vice versa using Mnarani Natural Aquarium, Baraka Natural Aquarium, Chumbe Marine Conservation and Zanzibar Marine Sanctuary as a case for the study. Specifically the study sought to assess the influence of Preparation of fish farm/ponds, Fishing by Small Net, Fishing using Bomb and Toxic Gears, Disposal and Antibiotics on Environmental Conservation.

3. RESEARCH METHODOLOGY

In this study the exploratory research design was employed. This design is mostly used to explore the back ground information about the nature of the research problem. Through this design the primary and secondary datasets, analysis, case studies interviews, questionnaires and discussion with focus group was used. In this study 5 people from each site was used as key informants and the remaining 15 were given close ended questionnaires. Other sample size was the people living nearby the study sites and the study purposively select about 25 people from each village site as respondents.

The tools which were used to collect data are questionnaire, interviews, and observation (i.e. using both the water proof and local cameras, swimming boots among others). The collected information from all data collecting tools was recorded, sorted and analyzed using the free access excel work sheet so as to make clear judgments.

The data collected using the aforementioned methods was sorted and some statistical parameters (mean, standard deviation, anomaly among others) were calculated using excel work sheet. Various plots and pie charts relating the parameters under investigation was plotted, analyzed, and interpreted based on the specific objective on target. Furthermore, the study used both the Qualitative (descriptive) and quantitative data analysis techniques to seek for the answers of the stated research question. Indeed, the visual interpretation of the photographs and images taken during field work was conducted. During the data analysis, the study mostly used the excel worksheet for analysis and plotting the results.

4. RESULTS AND DISCUSSION

To results of the analysis respondents responses on the extent to which preparation of fish farms affects the environment of the surrounding showed male (61%) were more eager participate in discussion than were female (38%). Moreover, the results show that young respondents were more interested to participate in this research as compared to aged ones; this may lead to miss some past experience towards the understanding of the influence of fish farming activities on environment. Indeed the results revealed that preparation of fish farms results in clearing of coastal forest, bare lands/shrubs which may degrade both coastal and marine ecosystems if not handled in great controls. For instance, 27% and 36% of responses at Beit el Ras, and Baraka admitted to the clearing of forest during preparation of fish farms, while 81% of Mnarani respondents admitted that clearing of the forest which is among the agents of environmental destruction was taken place during preparation of their fish farms. On analyzing the influence of weather and climate to the fish farming areas, 44% of the responses were not aware of weather changes, while 27% and 24% showed that weather is in its normal state and not changing, and only 4% of the them were aware of weather changes.

Furthermore, results show that fishing gears including small nets, bombs, lines, Mishale and Utupa among others is widely used and with high frequency, even if these gears have significant impact to environmental health fish farms and other marine protected areas. For instance, the responses of the frequency of fishing per week using these gears revealed that 42.5% of the responses attend fishing in two times a week, 32.5% four times a week and 25% three times a week. Indeed the results revealed type of environmental destruction associated with these gears. For instance, the results revealed that responses on the types of catches were 33%, 44%, 18%, and 5% for mixed, medium, small, and big fishes respectively. The responses for the mixed fishes with other materials were 38% for sea grasses, 20.5% on corals and small stones, 13% on shelves and 10% on starfish ; indicating a great extent of over fishing hence disturbs the environment of the fish farms and marine protected areas by killing small fishes, eroding the corals as well as overfishing. As for the extent of fishing or approaching protected zones the responses show that 25% have ever attended fishing in protected zones and high frequency of responses for attending this illegal fishing were in Mnarani (9%) and Chumbe (7.5%) Figure 1 The penalties to those caught fishing in protected zones are also presented in Figure 1 where C1, C2, C3, C4 being the frequency of being caught with weights of 45%, 36%, 5% and 14%, with Chumbe and Mnarani being leading sites. Though the results shows that fishing in protected zones is prohibited and those being caught should be penalized, but the responses for whether caught and being penalized is only 22%, indicating that though the bi-law is existing but not effective. Moreover, the study revealed that on an instances where the bi-laws are active caught ones are either, punished (27%), paying bill (20%), polishing their gears (47%) and being sent to court (7%), with Chumbe, Baraka and Mnarani site being highly practicing the bi-laws.

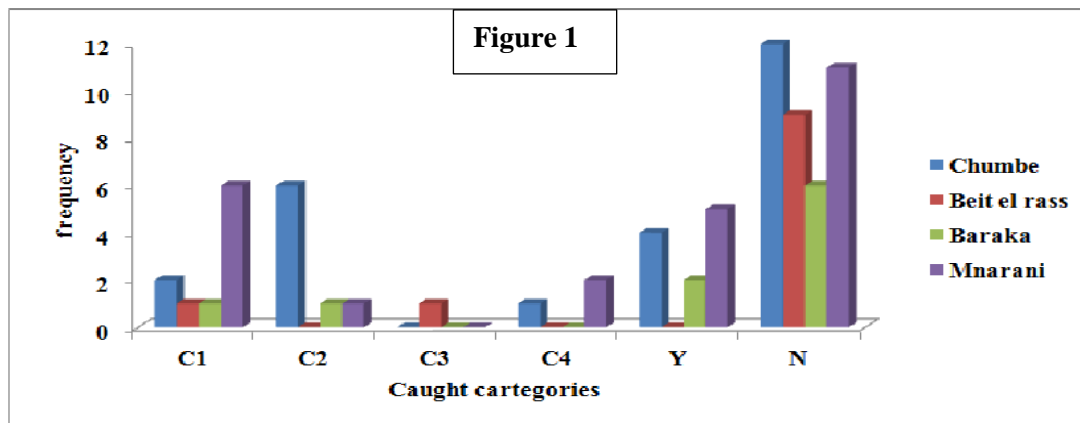
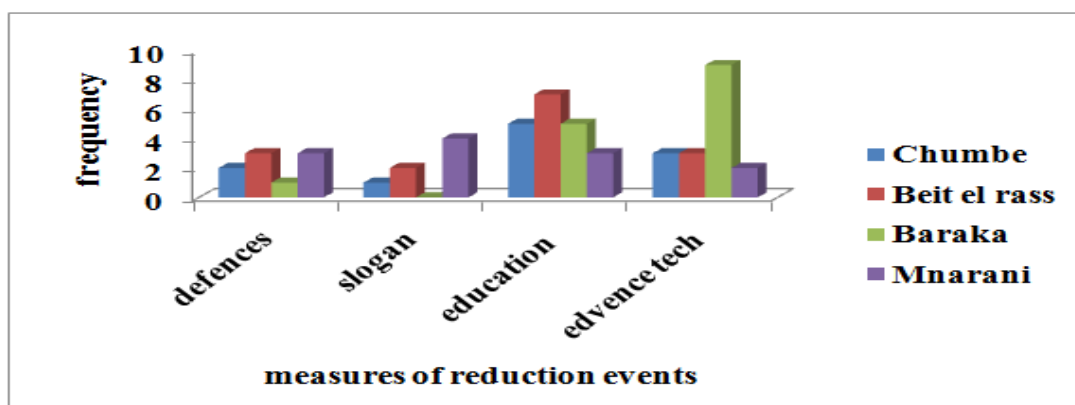


Figure 1. The frequency of being caught fishing in protected zones per month; where C1 indicates 1-2 times; C2 indicates 3-5 times; C3 4-6 times and C4 more than 6 times.

As for the fish farms management and government intervention on fish farm industry, the results show that to large extent fish farm owners are very sensitive to environmental destruction issues and around their fish farms, though tight practices of the existing bi-laws is not yet effective; as well supported by the responses from the respondents that prohibiting of unwanted materials to pop in the ponds weighed by 56% of responses; discouraging the use of plastic bags materials weighed 16%; and ensuring sustainable cleaning scheme of their ponds weighed by 20%. As for existence and influence of external forces to fish farms 37% supported their existence while 26%, 35% and 38% of the responses indicated that rainfall deposits, increasing of tree near the pond and the climate change (i.e. increase of temperatures raises the salinity level resulting low salinity tolerance fishes to die). Besides, results show that 44% of the responses support the existence of bi-laws governing the running of fish farms. These includes the licensing and its renewal period, and 48% of responses show that license is a necessary condition, while 67%, 12%, 16% and 4% revealed that licenses are renewed twice, thrice, once in three years and once in five years, respectively. Also results revealed existence of guidelines to facilitate working in farm as supported by 52%, and the frequency of reading the guidelines were 41%, 17% and 10% for once, twice and thrice a year, respectively. This indicate that both fishermen and fish farm owners are well aware about the bi-laws and guidelines governing the operating of the fish farm, but the community is resistant in taking action for un law full fishing. As for monitoring the marine and forest conservation areas 40% of the responses indicated that there are means of monitoring the environments around the fish farms as which include planting trees, guards throughout the time, keeping posters to prohibit throwing of unwanted materials as well as broadcasting in radios and televisions.

Also the study revealed that fishing using bombs and toxic gears affects biodiversity of both marine and fish farms as supported by 70% of the respondents. These types of fishing affect both forest and fish farms/marine habitat by killing the forest creatures which died fishes. Moreover, the study show that there exists some measures taken to reduce the extent and strength of bomb and toxic fishing which includes guarding, slogans, awareness (education) and advanced technology as shown in Figure 2 and the distribution of responses for these measures is 17%, 13%, 38% and 32% for guarding, slogans awareness and advanced technology, respectively.

Figure 2: Measure taken to reduce fishing using bombs and toxic traps



Indeed the study was eager to understand the types of chemicals and antibiotics used as fishing gears and treatment of infected fishes and results revealed that Chemi-clean, Chemi-pure, Methylene- plue, Proform-C, Microbe-lift-anchor- and anchor worm; are widely used as supported by 9%, 5%, 7%, 7%, 23.2%, 30.25 and 19% of the responses. Other chemical for fish treatment which were mentioned by interviewers are Oxytetracyclin and Sulphadiazine and Trimethoprim; but unfortunately 75% of the responses were not aware on the long term effects of these chemical gears and antibiotics. As for the frequency of using chemicals as fishing gears the responses were 20%, 20%, 46% and 14% for twice, thrice and always categories, respectively. As for penalties used for fishing using these gears the responses were 29%, 27%, and 44% for corporal punishment, accused to court and taking their fish gears and boats, respectively. As for the impacts of the waste disposals to the environments of fish farms and marine protected areas the responses were environmental pollution (36%), declining tourist visits (42%), and death of marine and pond habitats (22%); indicating that society is to a small extent aware about the hazards.

Moreover, the study show that respondents had some recommendation on the existence of the plastic materials to the fish farms and the responses fall on three key issues (Figure 3) which include measures to be taken for the peoples adding plastic materials to the fish farms which weighed 33%; bills should paid by those putting the garbage's to fish farms, which weighed 43% and lastly corporal punishment to those who are throwing disposals to the fish farms, weighed 25% .

Figure 3

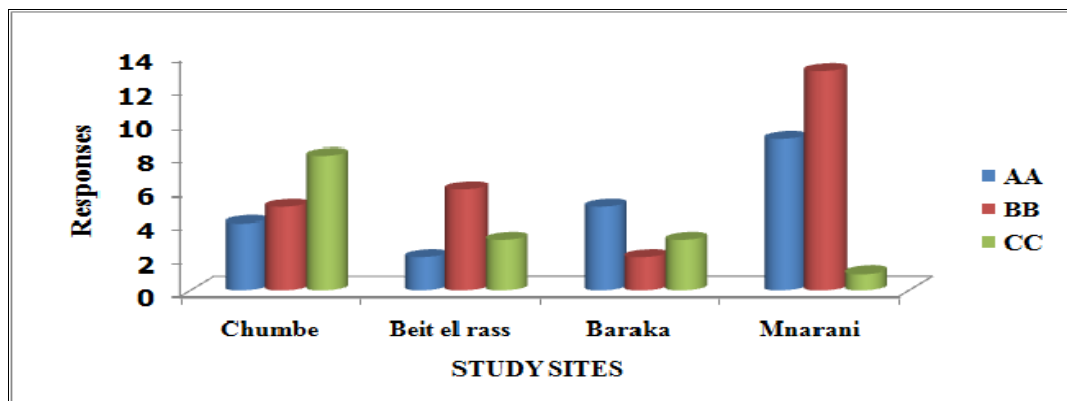


Figure 3: Recommendations towards disposals in fish farms; where AA stands for steps given to the peoples whose adding plastics materials; BB stands for fine/bill should provided to the peoples given unwanted materials and CC stands for corporal punishment give to the peoples go against the low to the fish farm.

5. CONCLUSIONS AND RECOMENDATIONS

The influence of fish farms preparation to the environment

The influence of fish farms preparation to the environment was critically investigated using various factors and techniques used to prepare fish farms, and presented results show that during preparation of fish farms forest areas, mangroves and bare lands are used. Moreover, during clearing processes number of creature (e.g. snakes, animals, millipedes, warms, birds and butterfly) living in the forests and shrubs were killed. Apart from destructing the environment, but also the biodiversity of the environment is disturbed. For instance, clearing of mangroves apart from destructing the environment, but also it kills small fishes, and affect the nursery ground, and on the other hand mangroves acts to prevent the coast line from erosion due strong waves, sea level rise and severe weather events, thus clearing mangrove results in increasing climate challenge vulnerability to the coastal line as supported by Dabi *et al.*, (2015) that fish farming has strong impact to the mangrove eco systems. Moreover, the study results have revealed that most young people's are interested in participating the research activities while aged peoples are not interested, this endangers missing of the opinions from the experienced. As for the diversity of the socioeconomic activities performed by the people over the study areas, fish farming and aquaculture in general have higher responses (15 respondents i.e. 19%). Besides the study revealed that peoples are changing perceptions towards fish farming activities, instead of being leisure and tourist activities now is considered as the socioeconomic activity and 42% responses depends on this sector; and the government intervention on clearing forest for establishing fish farms is of great concern. Thus the study conclude that fish farms preparation has

significant environmental impacts, and positive perception towards fish farming will enhance socioeconomic livelihood of the society, but overfishing may affect production and healthy of fish farms and the environment.

Influence of fishing gears to the environment

The influence of fishing gears including Madema, Mishale, Lines (Mishipi) small to medium nets and, Utupa have shown to have reasonable impacts to the environment, with higher strong environmental impacts on small to medium nets and Mishale have impacts by either affecting the corals, eroding the surrounding, taking out unwanted materials (like starfish, corals, sea weeds) killing small fishes, distracting the nursery grounds for the small fishes and hence degrade the environmental quality as supported by FAO, (2008, 2009). For instant, the study has shown Madema and Mishale and Lines (mishipi) are least used, but medium nets (33%) and small nets (31%) are widely used over all sites, with Baraka and Chumbe having high usage frequency. Also the study have shown that apart from fish materials like sea grasses (38%), corals (21%), small stones, (13%) and (10%) on shelves and starfish are eroded using nets. Also the weekly or monthly frequency of using these gears increases the speed of eroding the environment. For instant, the results show that 42.5%, 32.5%, 25% attended fishing twice, thrice and four times a week, respectively. According to Laham *et al.* (2012), normally harvesting frequency should either once or twice a month or week depend on the type of the species under acclimatization; this indicates a great level of over fishing hence disturbs the environment of fish farms and marine protected areas. Normally fishing in protected zones is restricted, but based on the findings of this study it shows that though bi-laws are existing, but are weakly implemented. For instance, the current study have shown that only 22% of the responses indicated that the caught ones were penalized, and responses for type of penalties and their weight were 27%, 20%, 47% and 7% for corporal punished, paying bills, polishing their gears and being sent to court, respectively. Indeed the study has revealed good techniques used by fish farms owners for farm management. These techniques and their weights in brackets include prohibiting unwanted materials to pop in the ponds (56% of re), ensuring plastic bags materials are not allowed (16%) ensuring a proper scheme for cleaning the pond (20%). Though the strategies look quite good but it seems that either they are not serious enough or the local and municipal governments are not properly adopting the penalties. Conclusively the study have found that fishing gears has great influence in affecting the environment of fish farms and marine protected areas; uncontrolled fishing affects the environment of fishing grounds and marine protected areas. Also there is a need to advance the monitoring technology for fish farms and marine protected areas to minimize the illegal fishing actives such as the use of unwanted gears.

The influence of toxic gears to the environment

The study have shown that fishing using bombs and other toxic gears to the health of fish farm it is not commonly known and only 18% of the responses indicated that toxics gears are being used, with high frequency at Baraka. Moreover, the study have revealed that 29% of fishermen around or nearby farms or marine protected areas appealed that Utupa is allowed, though 48% of the respondents had negative attitude towards Utupa due to its large effect. The use of toxic gears like Utupa and other disposal is strictly forbidden in the GRoZ, (2014) fishing policy due to its impact that apart from fishes of different types and scales as supported by 28.5% of interview responses that small and medium fishes including coral and sea grass and other species are affected and hence disturbs the biodiversity and the environment at large. Also the study revealed that though bomb not allowed, but are used as fishing gear as supported by 49% of the responses. Unfortunately 48% of the respondents they did not know the great impacts of using bombs, but 28.5% of interviews mentioned that fishing using bomb kills large number of fishes destroy coral environment and degrade the water quality. Also 74% of responses indicated that bombing degrades the corals and sea grasses as well as water quality, and the individual responses were 43%, 13%, 26%, 17% for destroyed, decreased, eroded and affected, respectively. As for impacts of bombing and Utupa on water quality (i.e. in color and test) 48.4% of the response agreed and 68% for change of state; indicating that bombing affect water quality by increasing dust, change in color and test. Moreover, the study have revealed that other habitats like for birds, animals and millipedes, which lives around the fish farms and marine protected areas were affected by bombs and Utupa fishing as supported by 43%, 38% and 19% of the responses. The measures taken to reduce the extent and strength of bomb and toxic fishing the study proposed strengthening of guarding, putting number of slogans, raising the awareness (education) and use of advanced technology such cameras. Though the study have shown that their exists government interventions to fish farms and marine protected areas, in areas of taxes collections (40%), pleasure (10%) and tourism attraction (50%), but it seems that much have to be done to protect the fish farming industry. As for challenges facing the fish farms and marine protected areas the presented responses were lack of technology, lack of proper monitoring techniques(education), poor government support (in subsidies and proper policy),

and neighbors disturbance (i.e. disturbance brought by neighbors on approaching the farms without permission). Thus conclusively the study stated that toxic gears including Utupa, bombs among others have great significance in affecting the fish farms and marine protected areas and their nearby environments and both marine and forest biodiversities; thus the study argued that proper government intervention and extensive collaboration between fish farm owners and the society is required for improvement of fish farming industry.

Influence of Disposals and Antibiotics to the Environment

The study results on the influence of disposals and antibiotics to the environmental destruction on fish farm and marine protected areas showed that chemicals are used in harvesting, as supported by 37% of the responses. Moreover, study revealed that spirit (41%), gases (30%), and acid (27%), which are mostly used results into death of fishes and other organisms. These acids and chemicals have great impact to pond and marine creatures and the environment as supported by responses from both the interview and 46% of questionnaires responses. As for the types of infection, the presented results revealed four types of infection which include viral (25%), bacterial infection (76%) and Fungus infection (8%) where water mould and fungus were responses from the interview respondents. The presented results on the frequency of treatment of infected fishes shows high frequency responses of 30% and 37% for twice and thrice a month, respectively. Moreover, the presented results revealed that only 25% of the responses were aware of the long term effects which include the death of fishes, deteriorating of quality and health or weight of fishes. Though the usage of spoils as fishing gears is not allowed as indicated by 55% of the responses, but the presented results show that there exists a 30% chance that spoils are used as fishing gears with frequency of 20%, 46% for twice and thrice for a given period. As for the impacts of these spoils to fish farms and marine protected areas the study shows that poisoning (65%) and the environmental destruction (35%) were among the main concern. As for penalties given to caught ones the responses indicated the corporal punishment (29%), accused to catch (27%) and taking their fishing gears and boats (44%) as well as paying bills or arresting them. For improving the environments around fish farms and marine protected areas for the life of all habitats, increasing security, providing good government support, technological advancement and keeping the areas silence were the main presented responses. Furthermore the study have shown that there are great synergies (dependence) between the marine and forest habitats in terms of food (both marine and forest habitats gets food from each other), defense (i.e. the forest habitats acts as shelter to the marine habitats, and the existence of the fish farm makes the forest to be not cleared) and security (i.e. the forest habitats acts as a defensive mechanism to the ponds habitats). As for steps towards the environmental protection of fish farms and marine protected areas the study results on the existence of dust been, 62% of responses show that dust been around, and also 63% show that plastic bags are not allowed around the farms and marine protected areas, as for disposals 52% of the responses revealed disposal are seen floating in fish farms, where these disposals include plastic bottles (47%), papers (19%), plastic bags (11%), aluminum materials or foils (2%) and 19% for other materials. Moreover, the respondent's recommendation on the existence of the plastic materials to fish farms provides number of steps to be taken. These include paying bills (33%) and corporal punishment (25%). Base on the impacts of these disposals the presented results showed that disposal pollute the environmental (36%), declining tourist visits (42%), and death of marine and pond habitats (22%). Thus the study concludes that disposals and antibiotics have significant impact to the life of marine creatures and the environments at large. Also antibiotics used either as fishing gear or as a treatment to the affected fishes may have long term impacts to both fish's environments and consumers of fishes. Moreover, mechanism of environmental protection and the bi laws should be strengthened to protect the fish farms from external destructive forces; extensive awareness on sustainable fish farming activities should be raised to the fish farm owners and local government for smoothly running of fish farming industry.

On view of the presented results, discussion and conclusions, the study recommends that

- (i) The government through the department of environment should have to provide clear and environmental friendly guidelines for preparing the fish farms and marine protected areas.
- (ii) Great campaign should be initiated to boost fish farming activities as a substitute of foot fishing and other less income activities.
- (iii) Government support in terms awareness (seminars and training), financial and material should be provided to enhance the boosting of fish farming which the key component for food security.
- (iv) Bi-laws should be strengthened to limit the use of toxic gears and disposals and well as antibiotics

- (v) Extensive study should be undertaken on what antibiotics to be used for safety of fishes environment and the user of fishes
- (vi) Collaborative techniques should be undertaken between the government units, local governments and the owners of the fish farms to campaign for sustainable environment on fish farms and marine protected areas
- (vii) Penalties and advanced monitoring technology should be revised to discourage the illegal fishing activities.

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