



Sea cucumber fishery characteristics in Tanzania

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Abstract

Sea cucumber fishery represents an important share of the coastal fishery of Tanzania, even if it has been poorly investigated until now. In order to improve the management on this fishery we studied the *H.scabra* and *H. nobilis* fishery, with the following aims: (a) to characterize fishery and fishing activities together with their socio-economic aspects; (b) to provide baseline information on the sea cucumber fishery, (c) to discuss the changes in this fishery as a consequence of the implementation of a ban 2006. The information was collected over the 2005–2007 period by means of interviews, on fishery features, fishing gear used, catch and socio-economic data. Sea cucumber fishers are categorised as (collection, processing, bulking, and exporters). The fishery is characterized by various vessels (ranging from 7 to 12m). The average CPUE (g/fisher/hour) values of *H.scabra* and *H. nobilis* is *H. nobilis* 0.5 in Kunduchi, 0.4 in Buyuni, 0.6 in Kitoni and 0.3 in Magemani and was dominated by men (64:4, n=68) with few women seen collecting, fire wood and processing sea cucumbers. Energy source, knowledge and lack of training affect total costs for processing, disparity in income, and individual fishers wealthy. One way ANOVA showed significant difference in wealth among sites and fishers ($p < 0.0001$). The migrants have positive and negative effects on destination villages. The differences in stages of social changes and infrastructure influence fishers' perceptions, knowledge, exploitation and their solutions to their sea cucumber fishery problems.

Keywords: Sea cucumber; Fishery; characteristics; *H. scabra*; *H. nobilis*; Tanzania

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1. Introduction

Several invertebrate species largely coastal benthic organisms with high commercial value are subject to over-exploitation by the small scale fishers and in some instances, depleted (Jamieson, 1993). Communities living close to the sea range from modest gleaners of shallow water through small scale to mechanized middlemen traders. The fishers in these areas began their social evolution as gleaners and subsequently evolved out of necessity into trappers and aqua-farmers (Jamieson, 1993). With time and where resources allowed, coastal cities and social hierarchies emerged, with distinct classes ranging from boat owners, through middlemen to fishing community leaders in social development. In most exploited locations fishers aspire to become developed with the associated lifestyles or livelihood they have seen or heard about.

The type of fishing gears and practices on the ecosystem have a relationship with livelihood of the fishing community, level of habitat degradation, and the biology of the resource harvested in an area given season in the boom and bust cycles of fishery (Grainger and Garcia, 1996). The “boom and bust” cycle has socioeconomic effects on local communities (Ibarra and Soberón 2002; Jangoux *et al.*, 2001). Within improvement in fisheries management and development policy, the importance of sustaining small-scale fisheries is increasingly being recognized (Johannes, 1978; Ruddle, 1992). Most studies of small-scale fisheries in developing countries have tended to emphasize small-scale fisher folks’ resource dependence and the open-access nature of fisheries that together lead to resource degradation, poverty and marginalization (Geheb, 1997; Christy, 1986). In the Western Indian Ocean, the sea cucumber fishery has existed for over a century as a livelihood source in many coastal households.

In Tanzania sea cucumbers fishery is conducted for cash from fresh animals by processing (drying) to produce beche-de-mer and exportation thus creating a source of employment and income to people. In some locations, individuals or family and groups in coastal regions are highly dependent on this fishery to the extent of causing localized depletions which lead to the ban of the fishery. Sea cucumber fishery was done without consideration of variations of descriptive information on location and quantification of resource. One of the two major causes of such variations in the fishery resources is the wide varieties of social status and sea cucumber fishery features which impact the validity and effectiveness of regulatory measures and instruments (FAO, 1985).

Sea cucumbers are consumed in Chinese restaurants in and outside Tanzania. Twenty two species are dried and exported from Tanzania to South-East Asia where they are considered a delicacy; the most important ones being: *H. scabra* and *H. nobilis*. Sea cucumber fishery in Tanzania is small-scale or artisanal and labour intensive form performed by men, women and children. Although sometimes mechanized, more often these small-scale methods involve fishing from small boats or from shore, or by gleaning and use of traditional fishing gear, or hand collection methods. Changes to fishing operations in some shores can’t have resulted from depletion of animals and are likely to extend beyond shallow water simply impacting on employment and fishers’ livelihoods. Due to the indirect impacts on the supply chain and the linkages within the fishery system, other stakeholders and subsectors can also be affected including supply of inputs to the fishing operation through “upstream” activities, such as (i) investments (e.g. vessels, engines and gear); (ii) operational costs (e.g. fuel and labour costs); and (iii) maintenance costs, and “downstream” activities such

as post-harvesting (e.g. processing and marketing). Similar impacts may exist for other resource users, for example, in the tourist sector.

In Tanzania, sea cucumber (locally known as Majongoo bahari) fishing is an important economic and subsistence activity for local communities and is extensively practiced (Mmbaga, 2002; Eriksson, 2011). Traditionally, fishing for sea cucumbers has been dominated by old men, women and children during gleaning for sea shells, crabs and baits as a source of subsistence income, later; however young people have purposely and opportunistically become increasingly involved in sea cucumber fisheries due to depletion, a rise in demand and greater income opportunities. The buyers who process and sell to exporters later operated under Chinese agents along the coast cities (Dar Es Salaam, Tanga, Bagamoyo, Mafia and Mtwara) using special commissioned boats and employed crews to take the fishers to far fishing sites for large catch. While providing income to local communities, fishing intensity has remarkably increased, placed greater pressure on the resource and prompted the ban in 2006. The starting dates for sea cucumber fishing in Tanzania is not easily determined with accuracy, but from anecdotal information provided by old sea cucumber fishers. The known date of gazette management in Marine Park Area (MPA) near Kitoni goes back to 1995 (Guard, 2003). The rest of sites are defined as Intensively Fished Areas (IFA) (i.e. Kunduchi and Magemani) and Lowly Fished Areas (LFA) (i.e. Buyuni (protected by its remoteness) and Kitoni (protected by being in MPA)).

High-value species (e.g. *Holothuria scabra* and *Holothuria nobilis*) have been depleted from the fishing grounds such that fishers are now targeting lower-value sea cucumber species (*Holothuria atra*, *H. edulis*, *Actinopyga echinites*, *Thelenota ananas*, *T. Anax*). This trend is increasing due to high demand in the Asian market and the sedentary nature of the sea cucumbers which ease collection from the inshore habitats. There is no information on the fishery characteristics of important sea cucumbers that constitute substantial fisheries resource in Tanzania. The sea cucumber fishery is largely artisanal with a small commercial operation monopolized by a few exporters. The aim of this paper is to characterize sea cucumber fishery in selected sites and bring together quantitative and qualitative data pertaining to social economic development issues for effective management approaches in Tanzania.

2. Material and methods

2.1. Study areas

Data on the physical, biological and socio-economical characteristics of the area were gathered from (Mmbaga, 2013). These were further complemented by information gathered in the field with the fishing community. The study was conducted in four coastal villages (Kunduchi, Buyuni, in Dar Es Salaam), and (Magemani and Kitoni in Mafia). Kunduchi beach is about 20 km north of Dar Es Salaam City at 6° 40'S and 39° 13'E. Buyuni is 58 km south of Dar Es Salaam city. Magemani is located at 7°52'S to 39°42'E, outside the park between Mfuruni and Kilindoni villages. Kitoni is located at 7° 59'S 39° 35'E in Mafia Island Marine Park (MIMP), 18km from Kilindoni. The park covers an area of about 822 km².

2.2. Physical aspects

The sites were chosen to encompass a wide range of exploitation levels, wealth, fishing pressure, socio-economic and geographical locations. The climate is characterized as tropical humid, with three dry months during the year (August, September and October) with a mean temperature of 22 °C. May and June are the coolest and wettest months, with a mean temperature value of 28 °C.

2.3. Biological aspects

The study areas present a great diversity of ecosystems, such as sand, mud, rocky bottoms. Each of these habitats possesses faunal and vegetations which favour sea cucumbers. Echinoderms including holothuroidea occur along these Coasts and are highly diversified. For example 11 species of sea cucumber were identified in shallow waters along the coasts and other 10 are found in relatively deep waters. Both selected shores are occupied by human and allow some varied economic activities, but also varied level of pollution due to the production of domestic waste.

2.4. Socio-economic aspects

For the purpose of this study, the areas were delimited as the areas within two municipalities of Kinondoni and Temeke. Within this limitation, Kunduchi lies close to city of Dar Es salaam and highly exploited while Kitoni village lies in MPA. Magemani lies close to Kilindoni town and also highly exploited as compared Buyuni which is in remote area from Dar Es Salaam city. The main economical activities vary including small-scale fishery. The communities in the selected villages vary on public services, fishing vessels, schools, medical services and credit services.

2.5. Data collection and presentation

Purposive sampling was used in identifying the respondents and were interviewed based on their willingness and availability. The respondents for the net margin analysis were: (i) the sea cucumber gleaners, (ii) middlemen and (iii) traders (native and immigrants). Other data was collected from published literature, discussions and field survey. Questionnaires were translated into Kiswahili and administered face to face to individuals of each category without gender discrimination. Notes were taken during interviews to fishers identifying level of wealth by categories and ranking criteria. The interviews aimed at discerning information on: levels of social infrastructure, categories of sea cucumber fishers in terms of activities and wealth, vessels and gears, preferred species, number of products, prices and value, trade routes, incentives in the fishery and fishers' social benefits advancement as well as migratory fishers and social tensions. I examined 10 wealth indicators that I hypothesized could be related to decisions by sea cucumber fishers to join, be in or exit a sea cucumber fishery: material style of life; household member; equipment (e.g., a boat and boat type) owned; age; years of education; proportion of catch sold; occupational diversity; and whether sea cucumber fishing was the household's primary occupation (Pollnac *et al.*, 2001).

Table 1 (i). Format on assessment of dependency and socio-economics of sea cucumber fisheries

Indicator / key questions	Records description
How do fishers of sea cucumber organize their activities?	Tasks categorizations in the fishery and mobility direction.
Economic activities performed by sea cucumber fishers	Number of occupations involved and its diversity
Occupational diversity	Number of different occupations employed in household
The status of the economy of sea cucumber fishers (Assets endowment)	Income from activities sea cucumbers activities; Assets owned: (especially house type, boat, diving equipment).
Involvement in social groups as a social capital.	Existence of groups or cooperatives
The contribution and motivational factors of sea cucumber fishery to the livelihood	Government assistances (credits, co-operatives, markets, species and prices) availability
Whether they are aware of the depletion and ban in their respective areas.	Yes /No: Reasons

In developing countries material style of life can be an indicator of relative wealth or social status within a community (Pollnac and Crawford, 2000). Material style of life measures wealth on the basis of household possessions or structure. I examined the type of walls, roof, and floor in respondents' houses and inquired whether they had a radio and access to a toilet. I examined the occupational portfolio of households by asking respondents to describe all activities that brought food or money into the household and to rank them in order of importance to determine whether sea cucumber fishing was ranked as their primary occupation or

not. Occupational diversity was noted i.e. the number of different types of occupations (e.g., fishing, agriculture, informal economy sectors). I also conducted interview-based surveys to examine how local fishers and immigrants context influenced variation in knowledge of sea cucumber availability in various locations.

I conducted between 23 and 34 household surveys in each village, making a combined total of 103 surveys throughout the study. I informed the respondents to choose if they don't want to be identified and assured that their responses would be treated with strict confidentiality and guarantee that the responses are not influenced by opinions of others, each respondent was interviewed alone. The information obtained with these interviews was tabulated in an excel spreadsheet program (Microsoft Office Excel) for analysis. Mean, variance, and coefficient of variations were then calculated for each data set. Along with these analyses, information supplied by the fishers which was not included in the questionnaire was also used to provide a descriptive characterization of the local fishing activity.

2.5.1. Data analysis

Data was analyzed in the field and after quantitatively condensing and categorizing it into groups of the same responses (Kvale, 1996). Analysis was done manually for grouped responses and answers presented through bar-graph followed by ANOVA and multiple comparisons using Student-Newman-Keulis post-hoc test. Validity and reliability of the answers was assured by reaching a point of saturation where no more new answer was given by focus group at each site while social tension was identified through explanation and reasons given after each interview question.

Table 1 (ii). Example of how interview statements were analyzed

Responses	Analyzed as meaning
Question: How reliable is sea cucumber resource to your household?	
* This is the only activity my father was doing & brought me up	*Is a meaningful activity
* This is what gave my family most of the things it needed	*It was a way of life
* It gave me all what I need in the past but not nowadays	*Fishery has problems nowadays

3. Results and discussion

3.1. Community trust

In this research I faced some difficulties especially in winning the trust of the community members. Being an occasional researcher on sea cucumber during my MSc, I was treated with suspicion due to the fact that the period of my field work coincided with a time of fishing ban in 2006. Sea cucumber fishers viewed me as a staff from the ministry of livestock and fisheries, hiding behind research monitoring illegal fishing activities. Sea cucumber fishers also decreased with time during the study as some thought I was an investor preparing to take their fishing ground for investing. Nevertheless through fishers gatherings before going to fishing and after fishing activities I explained to interviewees my intension and the number of fishers resumed and I was accepted.

3.2. Sea cucumber fishery and supply flow in Tanzania

Sea cucumber fishery and supply is presented in Figure 1 based on the interviews conducted, there are five important flow actors. These are; the collectors (gleaners, fishermen, divers), (processors-bulkier), middlemen, (traders-exporters). The chain starts with the gleaners, fishermen and divers.

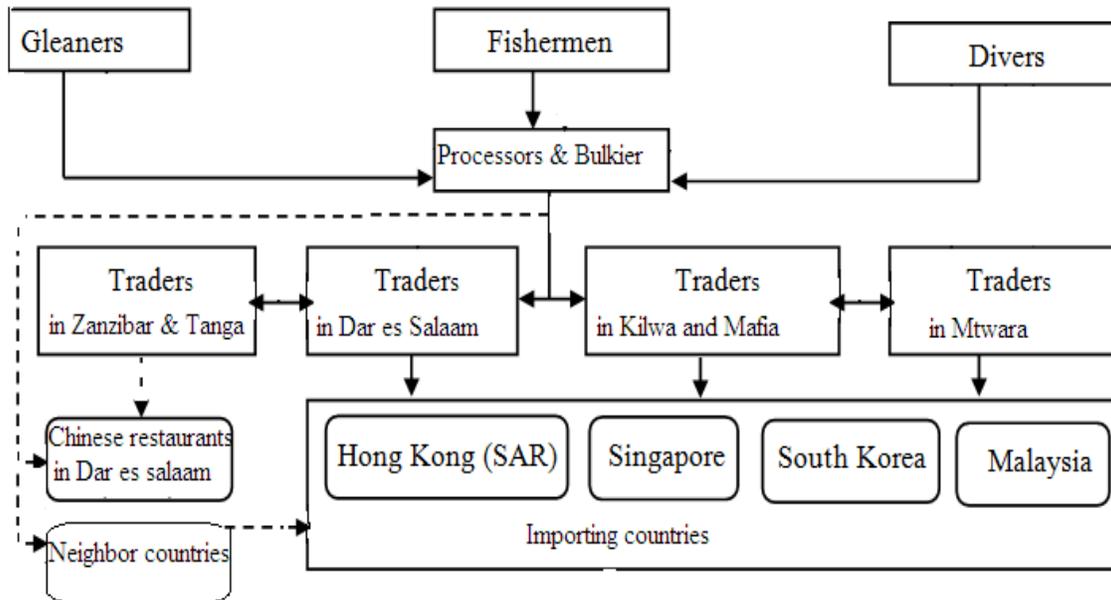


Figure 1. General sea cucumber fishery and supply flow in Tanzania

Under the traditional sea cucumber gathering method, 77 respondents were interviewed. They are composed of 40 gleaners (Collectors), 20 Processors-Bulkier, 7 fishermen (Opportunists) 4 divers, 4 middlemen, and 2 exporters. The general structure of sea cucumber fishery trade followed “collectors – processors-middlemen-exporter” chain relatively similar to that described by Conand, (1997) and Ochiewo *et al.* (2010).

3.3. Fishers working places and equipment in the study sites

Processing sites conditions and price manipulation also affect the quality and fishers income from sea cucumber product. The harvest of sea cucumbers like any other invertebrates is characterized by boom and bust cycles. Characteristics of working places and equipments and fishing vessels differed in term of quality as one go up to the export place. Processor premises in term of construction material, size of installations and organisation indicate the level of poverty. I observed variation in state of working place and equipment in processing sites (Plate 1 i, Plate 1ii, Plate 1 iii) which directly hinders the quality of beche de mer. As one goes higher in the production chain quality and advanced equipment were observed (e.g Chinese buying point Plate 1 iv and Plate 1 v). Plates 1 (i-v) indicate: (i) Boiling site (ii) Drying process, (iii) Inspecting the beche-de-mer ready for selling to middlemen, (iv) Middleman selling to exporters, 1(v) Re-processing and packing for export by exporter.

The conditions in the boiling site, drying process sites, storage and packing facilities for export cause poor quality of Tanzanian beche-de-mer and give chance for price manipulation. Fishers living in the close zone of the ocean were significantly poorer than people living further away, and they appeared to be in a poverty trap – they had generally little education perhaps due to being isolated from other non-fishing communities and so were disadvantaged when seeking other employment opportunities.

3.4. Sea cucumber fishing types, species and size preferred

There was a difference on how sea cucumber fishers along the coast value the fishery due to level of knowledge of sea cucumber value and income generation, kind of employment it generates. Women participated more in the sea cucumber fishery by collecting fire woods for processing to produce beche-der-mer. There was a site difference in species, demand of the middlemen who in turn represent the demand of exporting company and recipient countries (Table 2).

Table 2. Number of species, size and species selection in the study sites

Sites	Number of species observed	Size specificity	Species specificity	All species are harvested
Kunduchi	10	NO	NO	YES
Buyuni	15	NO	NO	YES
Kitoni	5	YES	YES	NO
Magemani	20	YES	NO	YES



1i Typical shore processing site of sea cucumber in Magemani at Mafia,



1 ii Sea cucumber drying using charcoal or sun or firewood



1 iii Typical rural household of local processor / bulkier at Buyuni.



1 iv Researcher and middleman sorting and selling sea cucumber by species at selling point (Chines buyer home-yard at Oyster-bay Dar Es Salaam).



1 v Home-yard based sea cucumber re-processing entrepreneur (Chinese bulkier at Oyster-bay), N:B The drier cabins are used to re-dry the beche de mer to the export standards.

Plates 1. (i-v) (i) Boiling site (ii) Drying process, (iii) Inspecting the beche-de-mer ready for selling to middlemen, (iv) Middleman selling to exporters, 1 (v) Re-processing and packing for export by exporter.

Most middlemen in Kitoni are species and size specific (*Holothuria scabra* and *Holothuria nobilis*) such that the collectors and processors do not buy other species or juveniles. The processors at this site have been taught to pre-process the sea cucumbers and travel to sell their catch in the cities e.g. those from Kitoni. Middlemen at Kunduchi, Buyuni and Magemani are non-specific in term of species and size and their collectors collect all species and all sizes. Some species e.g. *Stichopus horrens* although available in the fishing grounds of Kunduchi and Buyuni, they are not fully fished because few processors have knowledge to process them as according to literature they must be kept in water all the time until the time of processing. If left without water they normally collapse or disintegrate and become useless. It is only experienced fishers who can process *S. horrens*. In Samoa *S. horrens* is generally fished at night (to avoid collapse or disintegrate). The fishers in Samoa use their canoe bottom ("paupau") is filled up with seawater while processing the species. This is also done in the dugout canoe in Magemani in Tanzania. There is also the use of salt (marination) to process sea cucumber as recently observed in Buyuni Tanzania. This method was borrowed from Madagascar as is claimed to be a quick way of removing calcium carbonate on the body of sea cucumbers. In Madagascar (Rasolofolonirina *et al.*, 2004) it is also the way of limiting desiccation of eviscerated sea cucumber to minimize loss of weight during processing. A more advance method in post-processing in Indonesia (which was not observed in Tanzania) was onboard processing and smoking using wood and or coconut shells for 10-20 minute to produce higher quality beche-de-mer (Tuwo and Conand, 1992).

3.5. Sea cucumber fishers and household status

Under the traditional sea cucumber gathering method, thirty-five respondents were interviewed. They are composed of 4 gleaners, 7 fishermen and 24 divers. Fishing of sea cucumber in the study sites is primarily done by males. Despite the implementation of an ordinance banning, diving with the aid of compressor remains rampant in its use. Sea cucumber fishing community include; Absentee boat owners, Boat owners and fishers, Sea cucumber processors (mostly women), Support services (Boat building, Business of spares), Traders (middlemen). Within the sea cucumber fishers there are categories of activities (collection, processing, bulking, and exporters) (Table 3).

Table 3. Summary of the average respondent interviewed for social status and experiences

Site and /Fishers category	Ave age (yrs)	Gender(M /F)	Av. No of children	Av. No. of houses	Average number of household	Average number of owned	Av yrs of ed 0:7:14	Av. yrs of exp
Kunduchi (N=16)								
Collectors N=10	45.4	10:0	3.8	0.8	5.6	0.4	0:10:0	6.3
Processors N= 4	43.7	4:0	2.5	0.5	4.2	0.2	0:4:0	7.5
Bulkier N=2)	51.5	2:0	2	2	2	0	0:2:0	11
Buyuni (N=14)								
Collectors N=10	35.9	8:4	1.3	0.5	3.1	0.2	7:3:0	5.3
Processors N=3	36	3:4	3.3	1	6.3	0.3	0:2:1	5.6
Bulkier N=1	43	1:0	5	1	6	0	0:1:0	5
Magemani (N =24)								
Collectors N=10	40.4	10:0	2.6	0.8	4.9	0.5	0:10:0	6.4
Processors N=9	41.2	9:0	2.8	0.7	4.6	0.4	0:8:1	6.6
Bulkier N= 5	33.4	5:0	1	0.6	2.8	0.4	1:4:0	6.3
Kitoni (N=11)								
Collectors N=6	26.5	6	0.16	0.8	1.6	0.16	0:6:0	4.5
Processor N= 4	30.7	3.1	1.75	1	3.25	0.75	0:4:0	6.5
Bulkier (N= 1)	30	1:0	1	2	3.6	4	0:0:1	4

ANOVA showed significant differences among sites (Table 4).The fishery was dominated by men (64:4, n=68) in all levels (collectors, processors, bulkier and exporters) except few women seen in collection and processing.

Table 4. ANOVA comparison on age and number of children on sites

Aspects	ANOVA P-value	Multiple comparison	P value	Significance level
Average age	P< 0.0001	Kunduchi vs Kitoni	P < 0.001	***
		Magemani vs Kitoni	P < 0.001	***
		Buyuni vs Kitoni	P < 0.01	**
		Kunduchi vs Magemani	P < 0.05	*
		Buyuni vs Magemani	P > 0.05	ns
Number of children	P= 0.0232	Kunduchi vs Kitoni	P < 0.05	*
		Kunduchi vs Buyuni	P > 0.05	ns
		Kitoni vs Magemani	P > 0.05	ns
		Buyuni vs Kitoni	P > 0.05	ns
		Buyuni Magemani	P > 0.05	ns

The processors buy fresh sea cucumbers at the landing sites and perform the first stage of processing and bulkier do the drying and storage while mobile middlemen collects the beche-de-mer and sell to the exporters located in towns.

3.5.1. Age and household

There is high number of children in collectors and bulkier at Buyuni and Kunduchi which suggests a high dependence ratio as compared to Kitoni. Such a large proportion of children indicate a future of rapid population growth in the absence of significant outmigration. Elders described it to be caused by a large

number of children who soon enter into their childbearing ages. Social status of fishers of sea cucumbers and experiences differed in studied sites depending on several factors e.g. the age of fishers, experiences and accessibility of the locations by the middlemen.

3.5.2. Gender participation

Although women in sea cucumber are not conspicuous in this study role is significant but restricted to intertidal areas for a limited time of a few hours per day. They do collection of sea cucumbers, seashells and octopus usually during spring tides using hands. Few women are seen in the sea cucumber fishery doing the firewood collection and finishing processing of sea cucumber before sending to buyers in the cities. The nature of fishing grounds and the level of exploitation has played a crucial role in demoting gender equalities in the sea cucumber fishery. Traditionally, men have fished offshore while women have concentrated on inshore activities through collecting or gleaning of different species from the reef and other inshore areas. The offshore sea cucumber collections generate more income to have large animals. This results in targeting those areas and species at the expense of women. Therefore active participation of sea cucumbers is predominantly men's work as women did not join the offshore fishing activities in overexploited shores. Where women are involved in fishing, it is usually limited to shallow waters where juveniles are residing especially in lowly exploited shores hence fetch very low price and little profits. Other business activities involving women to travel are not supported by most coastal society such that immigrants arrival with such business have contributed to push the women outside the fishery perhaps due to cultural and lifestyle incompatibility.

3.5.3. Wealth status of fishers among sites

The categories of fishers' in term of wealth, was obtained using the indicators and ranking criteria as shown in Table 5 and the differences among sites (Figure 2).

High wealth in Kunduchi and Magemani is due high cultural diversity (caused by traders and business men) who are meshing the ethnic groups, most of them comprised of small communities that are gradually being assimilated into the larger ethnic groups due to changes in land use and the economic reasons.

3.5.4. Vessels, gears and license

The ability to earn income depends on the ownership of assets such as fishing grounds, crafts and gears which are inequitably distributed among sites / locations due to the social and economic imbalance. Some sea cucumber fishers in locations far away from cities (Kitoni and Buyuni) depend on other peoples' assets for livelihood. Looking to the vessel and gears types it shows that at Kunduchi and Magemani fishery methods are more motorized and organized with more activity in deep water. Fishery methods and fishing effort at Buyuni and Kitoni have not yet changed; they are generally small-scale and active mostly in shallow water. The observed size of boats ranges between 7 to 12 meters. The SCUBA equipment was observed at Magemani, but sea cucumber collectors were reluctant to accept using them in sea cucumber collection. The vessel types and times expended to fishing ground are shown in (Table 6).

Table 5. Fisher’s wealth categories and ranking criteria used.

Category	Category of sea cucumber fishers	Ranking criteria
Very wealthy	Middlemen, boat owners and exporters	Owning a small scale marine products company, skilled, at least one cement and iron roofed house, electricity, some live outside fishing village, immigrants
Wealthy	Boat owner, bulkier and agent	Skilled, have mangrove poled house and iron roofed, electricity, native or immigrants
Poor	Collector / or Processor, bulkier and agent	Less skilled, mud and palm leaves roofed house, native
Very poor	Collectors	Non skilled, mud and grass roofed house and native

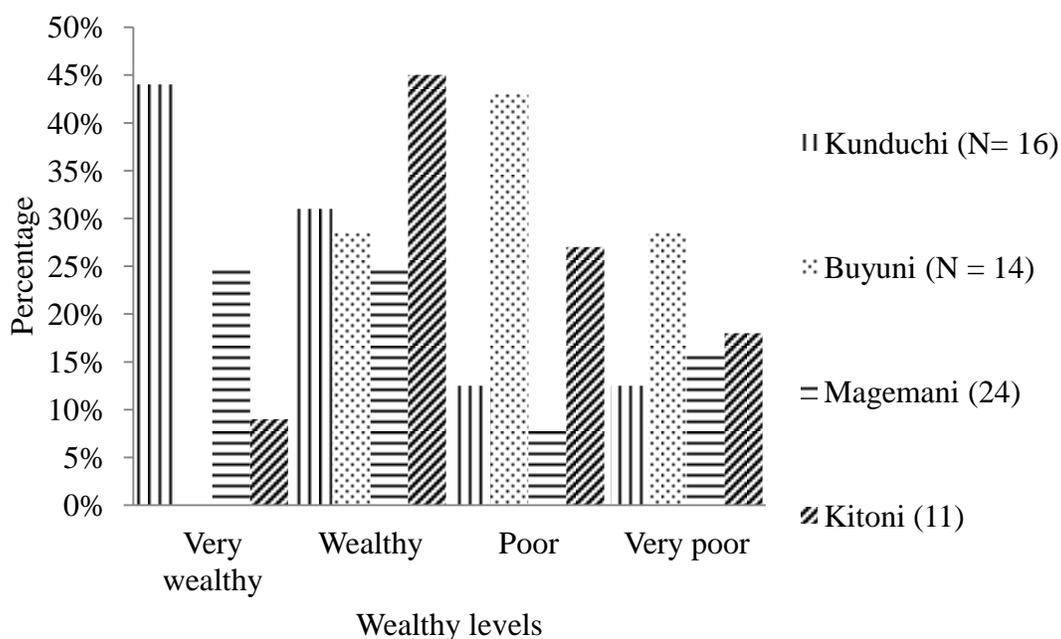


Figure 2. Wealth statuses of fishers of sea cucumber in the study sites

Table 6. Summary of vessel types and gears in study sites

Sea cucumber fishery vessels used	Kunduchi	Buyuni	Magemani	Kitoni
Canoe (Mtumbwi)	12	8	15	2
Outboard engine (boat)	1	0	2	5
Dugout canoe	9	10	13	2
Local beach facilities	0 (home)	0 (home)	4 + home	1
Distances exploited	Shallow and deep water & unselective	Shallow water, Close to shore & unselective	Shallow and deep water & unselective	Deep water & selective
Time spent to fishing ground	10-12 hours	3-6 hours	5-7 hours	4 hours
Fishing intensity (Sea cucumber fishers/km ²)	3.54	2.55	8.67	0.82
CPUE(g/diver/hour)	0.5	0.4	0.6	0.3

Fishing activities (number of sea cucumber fishers and vessels) were observed higher at Kunduchi while intensity indicators (fishers / area) were higher at Magemani and least in Kitoni. Within sites, native fishers need to own the fishing grounds close to their settlement while immigrants need the fishing ground to be owned by the government. Others have mixed belief of government and common ownership of the fishing grounds. The major difference in sites related to boat is that boat owners in Kitoni, and Kunduchi can also be used for tourism due to presence of tourist business not at Buyuni and Magemani. This ad up to more economic activities to these sites compared to others even during the ban.

For purposes of discussion, each site has fishing vessels which can be divided into the small-scale and large-scale vessels. In each site in the selected villages has no system of classification, while in theory world fisheries have classification system usually based on the type or size of boat employed. In my view, physical dimensions are not the most important distinguishing characteristic separating these two wealthy statuses.

More important are the fundamental differences in values and goals that distinguish these two groups of fishermen.

Most small-scale and native fishermen are restricted to operating in coastal waters near their home community by the size of their boats and the design of their fishing gear. Although the productive capacity of individual small-scale fishing units is quite limited, the large number of units involved frequently results in high levels of fishing effort in a small area. Therefore fishing effort distribution can be influenced by a number of social, economic, and institutional factors such as technology, management, and fishers' knowledge. Although ANOVA test showed significant difference among locations on who own fishing grounds as well as marine resources ($p < 0.0001$), there is a shift of toward owning of fishing grounds. However abnormal perception was at Kunduchi in which highest percentage of sea cucumber fishers believe sea cucumber fishing ground to be a common property from which nobody can be turned away than the rest of sites ($p < 0.001$) (Figure 4.2). This was variably but lowly reflected in other study sites.

One way ANOVA showed significant different between wealth among fishers of the villages among sites ($p < 0.0001$). Student-Newman-Keuls multiple comparisons showed the number of wealthy fishers at Kunduchi to be significantly higher compared to other sites ($p < 0.001$) (Table 7).

Table 7. ANOVA on number of vessels as wealthy indicator among sites (***) very significant; ** moderate significant different; * significant different; ns = not significant).

Aspects	P-value	Multiple comparison	P value	Significance
No. of vessels	P= 0.0002	Magemani vs Kitoni	P < 0.001	***
		Magemani vs Buyuni	P < 0.001	***
		Kunduchi vs Kitoni	P < 0.05	*
		Kunduchi vs Buyuni	P < 0.05	*
		Buyuni vs Kitoni	P > 0.05	ns

Endowment and ownership of fishing vessels, gear and beach facilities is important to be considered for the effects they create on the status of the fishery; not for the benefits of sea cucumber fishers because although respondents in most cases did not want to disclose the owner of the vessels observation shows that the owners are not fishers and have licenses. The involvement of non-fishers and immigrants on basis of their wealthy, boats (loans) catalyze the fishing towards over-exploitation resulting into income exploitation of sea cucumbers fishers that leads to their poverty. This was also the case observed in other countries (Ochiewo *et al.*, 2010; Eriksson *et al.*, 2010).

There are two main explanations for the role of low wealth in many small-scale fishing communities: exogenous origin of poverty in the fishery, in which low wealth arises from a lack of alternatives outside the sea cucumber fishery and endogenous origin of poverty in the fishery, in which resource overexploitation leads to poverty in the fishing sector (Gordon, 1954; Hardin, 1968 and Bene 2003). My results suggest that both these factors play a role in how fishers respond to fluctuations in the fishery. In particular, the respondents who were most inclined to remain in a declining fishery were those restricted by a lack of alternative occupations and poverty. The other factor is fisher's wealth given the numbers of activities or activity diversity and fishers income from sea cucumbers.

The sea cucumber fishery had been managed using a centralized management regime with a common license, the "Marine Product Export Establishment License". This license allowed the licensee to harvest, process and export sea cucumber. The license fee was Tsh. 150,000 per year. Once the license was issued, the licensee could harvest sea cucumber anywhere and never consider how much was available at his disposal. Sea cucumber is one of the most valuable fisheries in the studied villages after the Octopus fishery; however, in terms of value, some sea cucumber species achieve higher price per kilogram when processed correctly. The impact on poverty reduction depends crucially on how the license revenue earned by the government is translated into benefits for local fishers. The effect of fisheries licenses on poverty reduction will depend on the creation of economic 'spin-offs' and associated development activities. This study could not establish the actual financial benefits which could be earned by the license but it is obvious that this is a substantial amount.

Although sea cucumber fisheries dependent communities are economically better off than purely agricultural dependent livelihood earners, yet determination of profit margins for fishers and related activities requires complex analysis involving many variables and assumptions. This is complicated by the different gear types used, the use or non-use of boats and whether or not boats used are motorised. Whereas men go out to fish in boats, women mostly glean the intertidal areas for gastropods, bivalves and sea cucumbers but no periodic survey programme for fishing households and therefore no official information on fishers' income other than data collected in this study exist. There is distinct difference in income between boats with and without engines, though both practice the same fishing methods.

3.5.5. Occupation diversity and income of the household

Economic activities in the studied villages differs (Table 8) especially on when activity begun, magnitude and income turn-over depends on among other factors public social services, distance from markets and towns.

The level of fishing of sea cucumbers depends on alternative of other fishery and non-fishing activities conducted in the location / village. The number and diversity of fishing and non-fishing activities and income earning were more in Kunduchi and Magemani compared to the rest of the study sites (Table 9). The income from sea cucumber generally outweigh that from other activities especially for gleaners (elders, women and children) in areas with high abundance of sea cucumbers almost in all study sites. In some remote shore villages e.g. Buyuni and Kitoni alternative activities e.g. net-making and mending, fish processing, small-scale retail trade of fish and fishery products and livestock rearing are not applicable. In villages close to cities e.g.

Kunduchi and Magemani, such alternative activities significantly contributed in expanding employment and income opportunities for coastal women, old men and children.

Table 8. The diversity of occupations generating income in the study sites: √ = existing; x = do not exist

(B) Socio activities	Kunduchi	Buyuni	Magemani	Kitoni
Fishing	√	√	√	√
Sea cucumber collection	√	√	√	√
Mangrove pole selling	x	√	x	√
Coral burning	x	x	x	x
Canoe making	√	√	√	√
Land farming	x	√	√	√
Sea farming	x	x	x	x
Handcraft	√	√	√	√
Small businesses	√	√	√	√
Salt making	√	X	X	x
Tourism	√	X	X	√

The traditional ways of dividing the earnings per trip is that: after deducting the costs for inputs (boat fuel and boat services), the remaining part of the catch is divided in equal portions for the fishermen and for the owner of the boat. This means that if the boat owner participates in the trip he will receive two portions. 80% of the respondents use this as a method of dividing the earnings.

It should be noted that the fishermen, divers and gleaners also catch fish and molluscs which adds up to their total monthly income. The share of sea cucumber income to the total monthly income is at 57% at Magemani, 70% at Kitoni 69% Buyuni and 30%, at Kunduchi respectively. The fished sites are poorly managed sites with fishers of few economic opportunities who aspire to become rich with the associated methods of fishing and gears they have seen or heard about. The obvious implication is that those who are

unable to alter production due to geographical location, access to credit, or lacking title to property continued to produce traditional beche-de-mer and will not be able to escape poverty hence disobedient to fishery authorities. Copes (1988) suggests six reasons why opportunity incomes may be low in small-scale fisheries. These are: (i) the isolation of many fishing communities resulting in poor educational levels and infrastructure links as well as few alternative employment opportunities, (ii) the existence of surplus labour due to productivity gains, (iii) capital asset fixity, (iv) life-style preferences, (v) high-liner illusion and (vi) perverse assistance (i.e. welfare state measures designed to provide an income safety net). Similar factors are advanced by Panayotou (1982) to explain labour immobility, cultural factors and simple lack of knowledge of alternative occupations. Regarding the question on whether they would like to continue fishing in the location; the natives' stronger sense of belonging to the village and traditional activity may be a reason for fishers to blame immigrants. "They argue that to them as the owner of the locations takes care of the location because they love them, a person who does not care about the places does not respect them" said one retired old fisher.

Table 9. Sea cucumber fishers' house hold incomes and sea cucumber diversity

Site	Sea cucumber species diversity	Average income from sea cucumber /week (Tsh.)	Level of occupation diversity of House hold	Average income from other occupations/week (Tsh.)
Kunduchi	0.87	150,000/=	3.73	350,000/=
Buyuni	1.33	350,000/=	2.12	150,000/=
Magemani	1.67	400,000/=	3.54	300,000/=
Kitoni	1.23	530,000/=	1.67	200,000/=

3.5.6. Knowledge, training and experience of sea cucumber fishers

Among the respondents (n = 65) only 54 had primary education, 7 had no formal education at all and only 4 had secondary education, Kunduchi being higher in skilled fishers (informal trained) than other sites. The people with secondary education preferred to work as sea cucumber fishers in MPA due to low competition compared to villages away from MPA. Inequality in education, income, and occupation exacerbates the gaps between the wealthy "haves" and "have-nots" (Table 10). However there were also local variations in indigenous knowledge of sea cucumber fisheries between sites and between natives and immigrants. The

existing knowledge developed outside the formal education system over many years and passed down orally from generation-to generation. However this knowledge is variably disappearing as young people get modern knowledge and immigrants invest in their habitats while older people die without their indigenous knowledge being transferred. At Kunduchi and Magemani, variable access rights among fishers to the main habitats were sources of variety in knowledge. By contrast, knowledge was more homogenous for natives at Buyuni and the sole source of variation was gear type.

Table 10. ANOVA on average level of experiences among sites

Aspects	ANOVA P-value	Multiple comparison	P value	Level of significance
Average experience	P < 0.0001	Kunduchi vs Kitoni	P < 0.001	***
		Kunduchi vs Buyuni	P < 0.001	***
		Kitoni vs Magemani	P > 0.05	ns
		Buyuni vs Kitoni	P > 0.05	ns
		Buyuni Magemani	P > 0.05	ns

Social services e.g. education and training in sea cucumber fisheries is lacking but has been replaced by informal knowledge. There is no one who attended beche-de-mer handling training except one middleman who attended a workshop on sea cucumber processing at Kunduchi in 1985. Differences between locations in the knowledge on assemblages of sea cucumbers depended primarily on socioeconomic drivers of fishing effort rather than diving ability. While immigrant fishers were knowledgeable on sea cucumber aggregations and used shorter time and selective gears, native fishers were less constrained by locality and residency in their access to rich habitat. However, fishing effort was greater for immigrants and likely related to high dependency on sea cucumber fishing, greater access to good markets than natives and a weakening of local management. Understanding of how knowledge is structured within fishing communities and its relation to socioeconomic drivers of fishing effort is important if location based practices for conservation, are to be supported. The low education level prevents most of the sea cucumber fishers from getting a place in the work market other than in posts associated with collection activities while fishers with higher educational levels inhabit large cities with hiring boats in the fishing sites. Low education level is also associated with a

high level of early marriage and with the presence of children in almost all the fishers’ dwellings, which leads to an increase in the dependence from sea cucumber fishing.

3.5.7. Immigrants and opportunities in the sea cucumber fishery

Sea cucumber fishers’ movements are either temporarily or permanently to fishing grounds that are perceived to be potentially well endowed with abundant sea cucumbers. Fishers have also been known to move to beaches where they could get good prices for their catches and in anticipation of greater economic opportunities. Migrant sea cucumber fishers were of the age class 20 to 45 years, single and young and few married adults. They visit other fishing sites as missionaries to search for not only good fishing ground but also to identify weak regulations for displacement of fishing effort from highly- to less-regulated regions. Boat crew members moved much more in comparison to the married women and boat owners. The head of the household decides when and where to move. Most women did not move mainly because they had to remain at home to maintain and care for children. Women indicated that their husbands made decision to move either after being sure that the fishing ground has no restriction. Husband moved first and when established, he invited his family. Social networks contribute to movement as female migrants may also be invited by their friends who have already moved. The percentage of immigrants among sites was in the order of Kunduchi > Magemani > Buyuni > Kitoni (Figure 3).

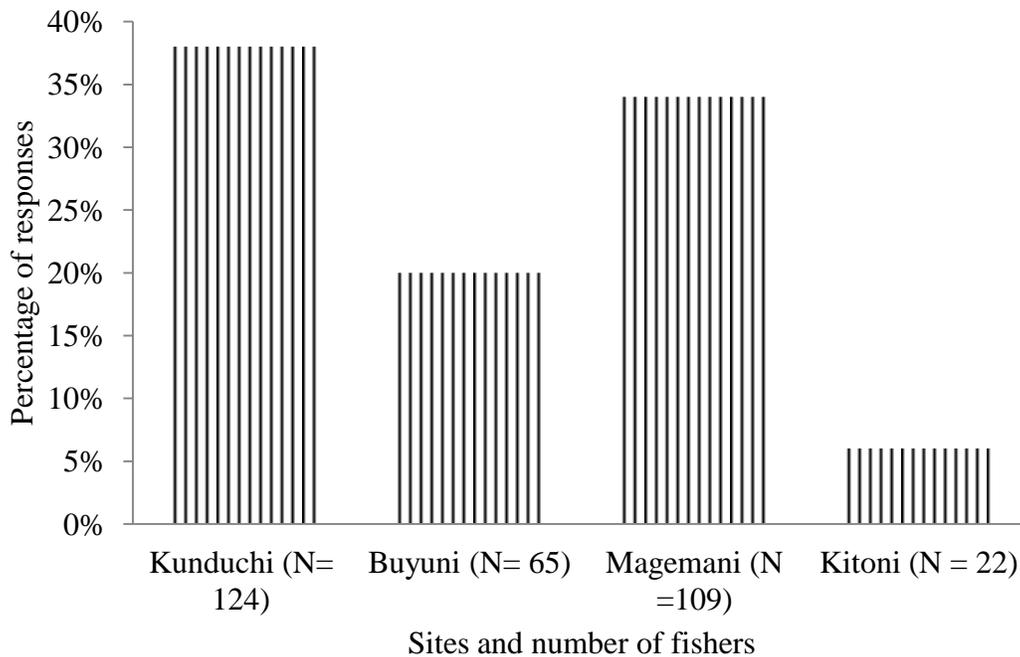


Figure 3. Immigrant percentage among sites

The seasonal migration of fishers has been also reported in other fisheries (Guard, 2003) to exploit resources at different locations under favourable conditions. In sea cucumber fishery immigrants were noted by their temporary set camps, huts thatched by coconut trees leaves where they stayed for 3-6 months before they return to their home locations. Some immigrants change from transient to permanent settlement as clearly seen at Kunduchi, Magemani and Buyuni. However one old fisherman described the conflicts caused in fishing grounds by migrating fishers who use scuba, collection of small sea cucumber and destroy traps (madema) of native fishermen in the fishing grounds. This was one of the reasons causing the local fishers to hate immigrants. Social reasons such as conflicts insecurity and congestion also play a role in sea cucumber fisher mobility. Fishermen moved when they were found with unacceptable character such as theft, practicing witchcraft and immorality. Misunderstanding and conflicts with the native, leaders or other resource users was also a reason for some to migrate. Greed as well as competition over resources motivates conflict over resource use. The problems of immigrants is the same elsewhere e.g. intensive fishing (Guard, 2003), ignoring native tradition respects to the village leaders, rules and ethics which served as a mechanism to preserve the resources.

Reasons for migrations differed among fishers however there were general ones including: economic hardship in their sites, approaching good fishing grounds, to follow better market and new experiences. The recipient sites of immigrants experience negative impacts with different intensities (Table 11) depending on the number and categories of immigrants.

Table 11. Likert scale showing response of native fishers on level of impacts of immigrants (0 = None; 1 = very little; 2 = Little, 3 =High, 4 = Very high)

Effects caused by immigrants	Kunduchi (N=16)	Buyuni (N=14)	Magemani (N=24)	Kitoni (N=11)
Destructive fishing methods	4	2	1	0
Theft of fishing gears	3	1	2	1
Desruption of values	4	2	2	2
Bad social behaviour (stiling, alcohol drinking)	4	1	2	2
Non-compliance to village traditinal fisher rules	4	2	2	1
Conflicts and social misunderstandings	3	2	1	1
Competition over development resources (loan,	4	1	3	0
Competition over sea cucumbers resource	4	1	3	1
Disruption of fishers community organizations	3	0	3	0

Where there is excessive levels of fishing efforts it lead to resource depletion, sea cucumber become increasingly valuable commodity at the bulkier poits. As the price rise, the ability of poor local middlemen to purchase sea cucumber diminish, therefore fishers outside MPA are variably forced to adopt increasingly other destructive fishing methods to meet their short term needs. In some cases, sea cucumber fisher groups are organized in small informal entities such as collectors groups or association, bulkier etc. Informally, the social organization structure of sea cucumber fishing communities varies (in term of age, knowledge, experience, household size, perception on depletion and hence response to depletion) between villages. According to sea cucumbers fishers' competitions for the resources affect residents (both natives and immigrants). Immigrants in some villages have a tendence of disrupting justice capacity of native fishers to organize their social, economic and political organizations aiming at mobilizing their energies for development and managing local resources..

Competition between small and large-scale fishermen is of two-kinds: competition over finite marine resource; and competition over scarce development resources. Direct competition occurs when both types of fishermen exploit the same fishing grounds and/or the same species of sea cucumbers particularly *Holothuria scabra* which are concentrated in coastal waters. Most small-scale fishermen are restricted to these waters by their simple fishing technologies. There is also ccompetition for development resources e.g. Governments may have fishing surveys, technical advice and training, related infrastructure and provision of subsidized loans. This results into social conflict particularly when there is destruction of small-scale gear by immigrants and wealthy fishers. The remote villages like Buyuni which are sanctuary for responsible and subsistence sea cucumber fishing multitude could now or later turning to a ground of golden rush for the valued sea cucumber given no ban of 2006 as what Eriksson *et al.*, (2012) called roving bandits. In some cases immigrants and middlemen bring into the village current and new knowledge, technology, gears and information helping the natives e.g. processing and market price and locations. The technological change could brought about through the introduction of a new fishing gears and vessels in the sea cucumber fishery was found to affect the level of earnings, labour mobility, and the revenues split between owner and crew.

3.5.7.1. Migration of fishers' groups and strategies in sea cucumber fisheries

Group formation by sea cucumber fishers in the fishery is a social strategies in relation to environmental, ecological and resources depletion (Figure 4 a and 4 b).

The benefits of the group formation; include increases searching success and monetary benefits. For illegal migratory fishers; the advantages of group fishers includes; reducing being conquered by other groups in the sea, increase practical learning and knowledge heritage through interaction (Figure 4 b).

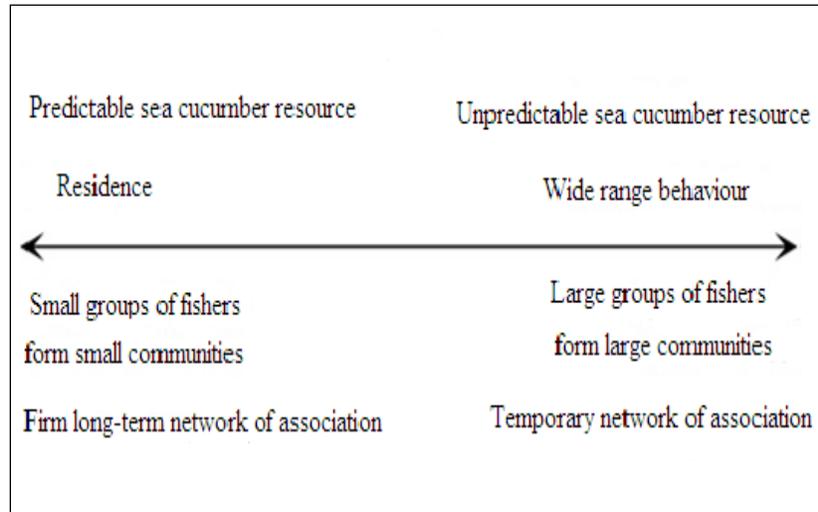


Figure 4 (a). The influence of ecology, in particular the predictability of sea cucumber resources on the changes of social structure in fishers (fishers behaviour, group size and formation of association).

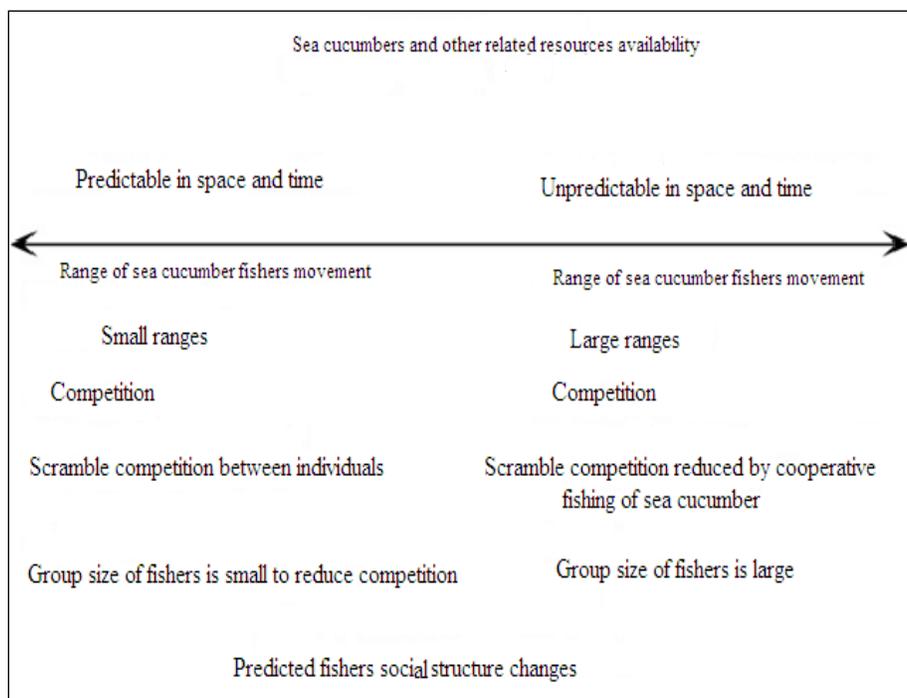


Figure 4 (b). Fishers’ socio-ecological sketches on the influence of the predictability of resources on ranging behaviour, scramble-type competition levels and group size.

Contrary to migratory fishers, native fishers have a long term residence ownership with intimate knowledge of sea cucumbers habitat. This finding is important because it indicates that small-scale fishermen have the ability to restrain themselves from maximizing personal gain at the expense of the collective good. This social consciousness provides a basis of resource management.

3.6. Sea cucumber resources characteristics

Monthly catch data for *H. scabra* and *H. nobilis* have high fluctuation at Kunduchi than in Buyuni. The landing by wet weight (kg) of *H. scabra* and *H. nobilis* was generally higher during July-December (2006) and lower during February-July (2007) and higher again during August to December (2007) However the weight of *H. scabra* at Kunduchi was higher compared to that of Buyuni because of high gears and divers. The level of exploitation as expressed by landing characteristics differs from shore to shore depending on fisher folk's experience, the number and category of fishers, fishing techniques and season (Figure 5 a and 5 b).

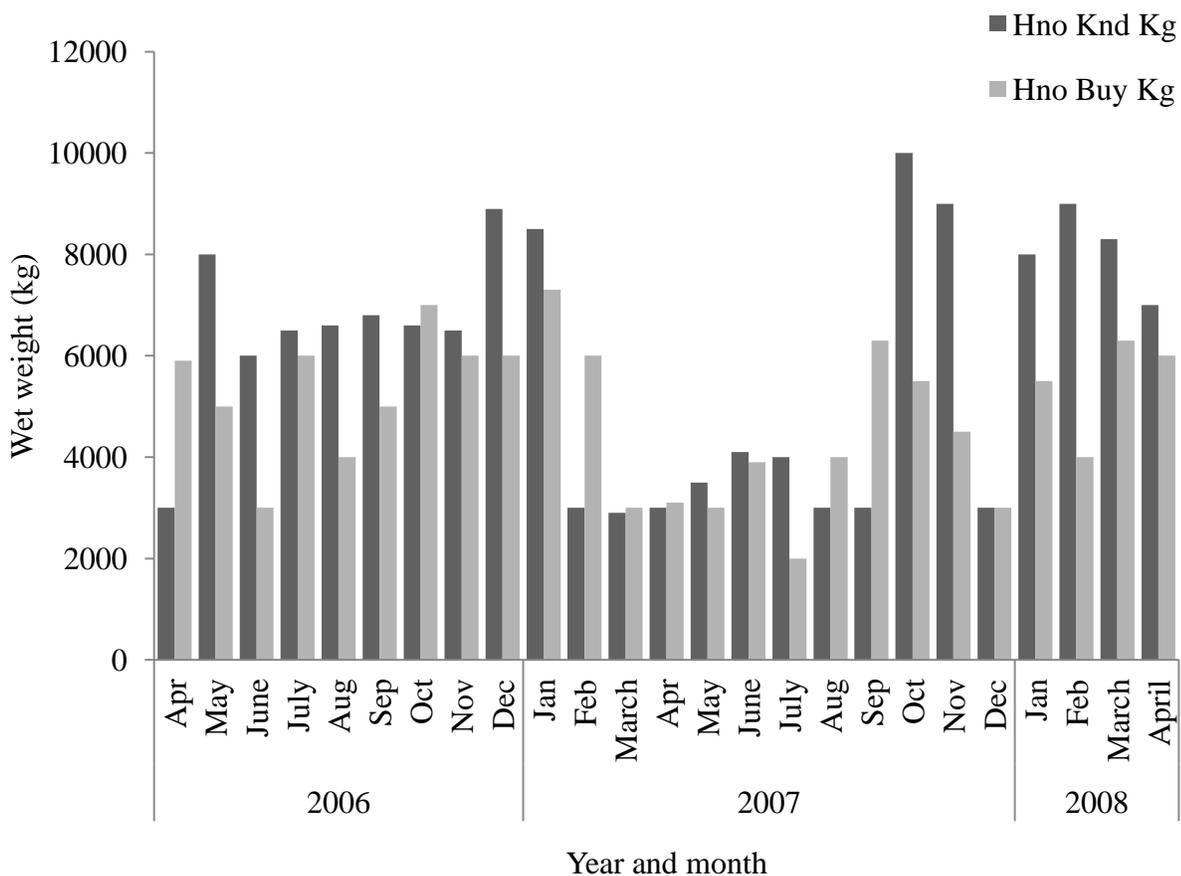


Figure 5 (a). Monthly landing (wet weight) for *H. nobilis* at Kunduchi and Buyuni

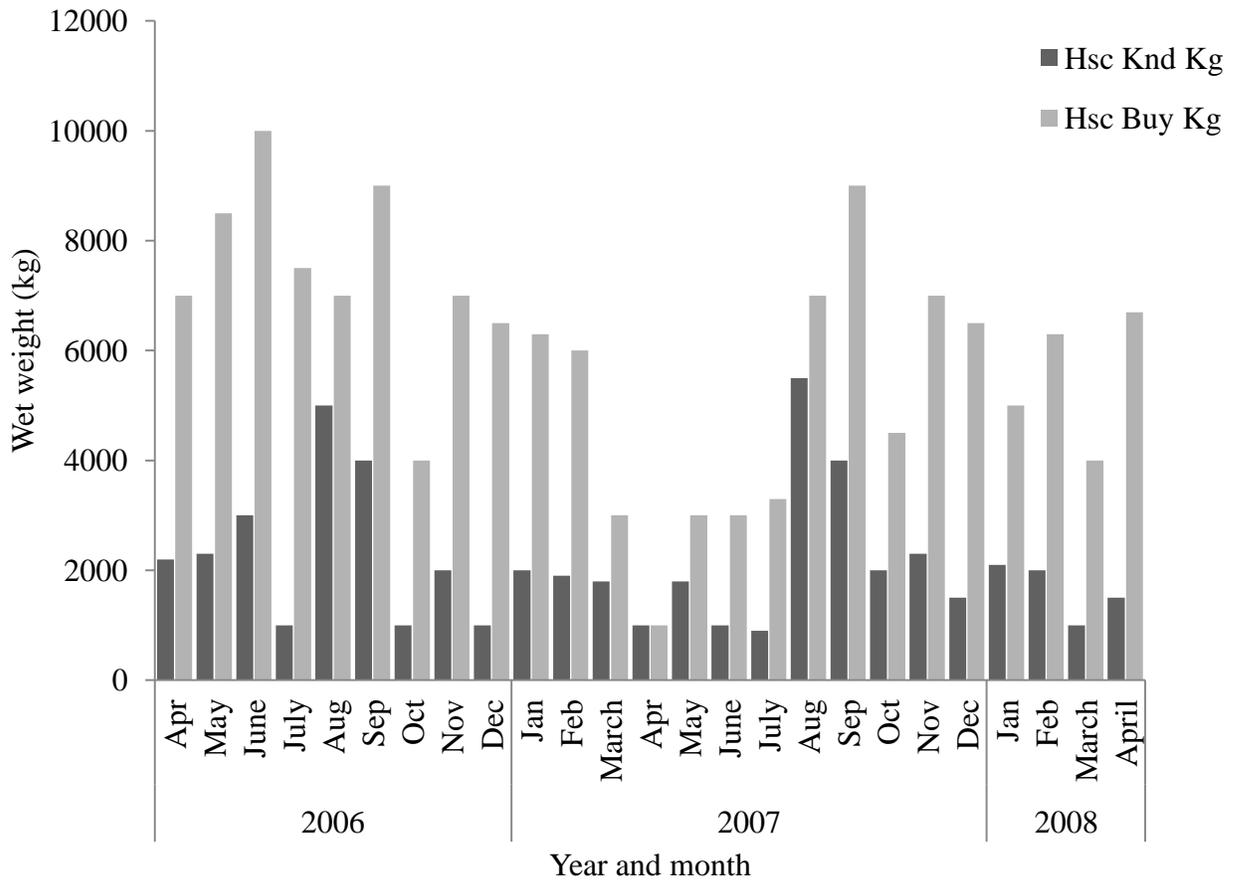


Figure 5 (b). Monthly landing (wet weight) for *H. scabra* at Kunduchi and Buyuni. (Key: HnKnkg = *Holothuria nobilis* at Kunduchi in kg, HnBy kg= *Holothuria nobilis* at Buyuni, HsKn kg= *Holothuria scabra* at Kunduchi in kg and HsBy kg = *Holothuria scabra* at Buyuni in kg).

Since 1999 the number of species reported to be collected have been increasing e.g. in Mgaya *et al* (1999) recorded 5 species without giving the weights; Mmbaga and Mgaya, (2004) recorded 10 species and Mgaya and Mmbaga (2007) reported 21 species also without giving quantity with the decreased most targeted species *H. scabra* and *H. nobilis*. Local exploitation occurred year-round on reef flats close to the shore or sheltered from the prevailing winds and that the main collection seasons were October to December and April to May. This is the period when the winds were usually light, and trips could be made to the off-shore reefs. Collection methods in the studies sites included hand-picking, by snorkeling and diving. According to gleaners the increase in non-fisher businessmen has promoted SCUBA diving to collect deepwater cucumbers

making the species vulnerable to over-harvesting. This was also reported in other areas of Tanzania e.g. Songo Songo (Darwall (1996b), Zanzibar, (Jiddawi, 1997), Mtwara, (Guard, 1998; Horsfall, 1998), Bagamoyo (Mgaya *et al.*, 1999) and Dar es Salaam (Kithakeni and Ndarro, 2002). The reported data collection is the cross border transfers of sea cucumber from Tanga to Vanga in Kenya and from Mozambique to Mtwara in Tanzania which complicate the export statistics.

The general weight frequency distribution of collected *H.scabra* and *H. nobilis* at Kunduchi and Buyuni showed range from: smallest (0-50g), smaller (51-100g), large (101-800g), larger (801-1000g) and largest (1001-2000g) (Figure 6 a and 6 b). Buyuni site have many smaller individuals of *H. scabra* and less large individuals. Kitoni have all sizes of *H. scabra* while Kunduchi have medium size *H. scabra* individuals only.

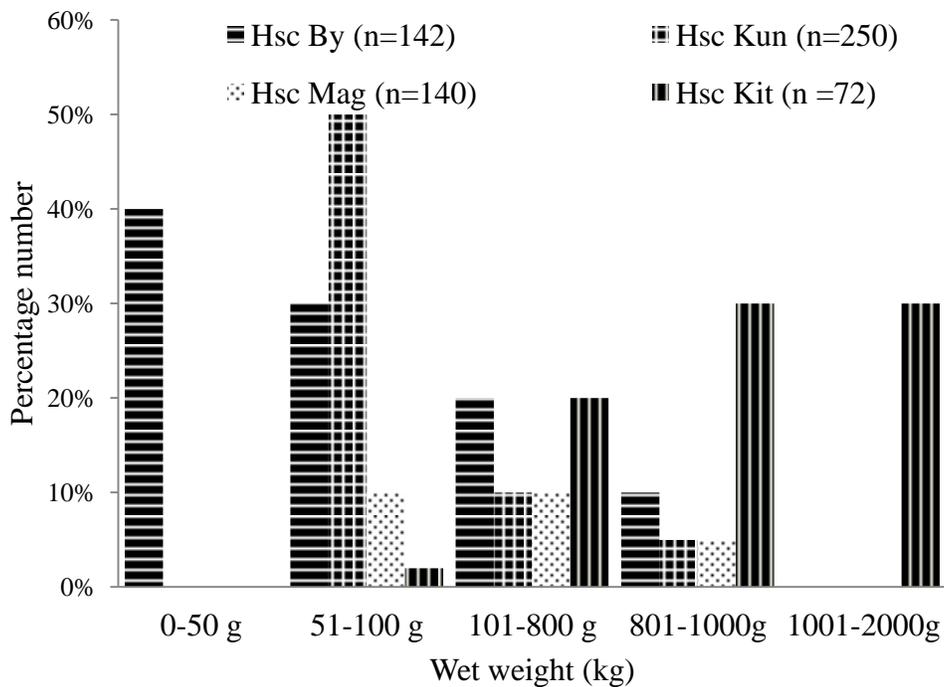


Figure 6 (a). The size structure (wet weight) of the sea cucumbers *Holothuria scabra* harvested in each site

In the case of *H. nobilis*; Buyuni had smaller, medium and larger individual while Magemani had many smaller individuals with few medium and largest individuals. Kunduchi have only medium individuals (Figure 6 b).

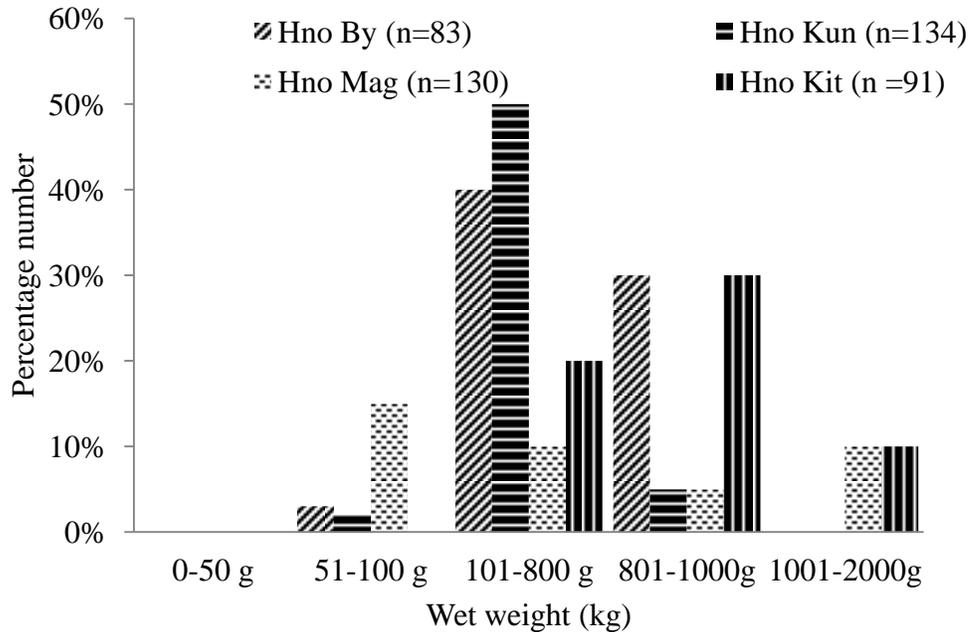


Figure 6 (b). The size structure of the sea cucumbers *Holothuria nobilis* harvested in each site

Fishers in reefs and lagoon areas at Kitoni and Buyuni can still find sea cucumber easily showing that there are still some relatively dense populations of main species compared to Kunduchi and Magemani. The size structure of the sea cucumbers *Holothuria nobilis* and *H. scabra* harvested in each site showed that the majority of animals collected at Kunduchi and Magemani are below estimated weight of maturity (320g for *H. scabra*, 420g for *H. nobilis*) in this study and 160mm for *H. scabra*; Conand, (1993) compared to MPA. The ratios of males to females of sea cucumber that are collected in exploited sites have shifted to more males 1:2, 1:4 and 1:8 an indicator of effect of over-exploitation on reproductive potential.

3.6.1. Social services and infrastructure in the study sites

Effects of site characteristics and infrastructure are considered in illiteracy level, health status, sea cucumber market, credits and loan facilities. These have a great impediment to the achievement of better household status to the fishers. Fishers in Buyuni and Kitoni like other rural areas rely heavily on only traditional medicines and healers because government health facilities are very far compared to Kunduchi and Magemani residents hence cases of ill health. There are more private health facilities in Kunduchi like other urban areas. The absence of healthy centers increases the use of traditional healers. The sea cucumber fishers in remote areas far from trading centres or road transportation (in Buyuni, Magemani and Kitoni) do not benefit from government opportunities e.g. awareness campaign, knowledge as compared to urban areas. Due to lack of permanent roads they are externally-led in decision on the marine resources.

Sea cucumber fisheries followed a pattern of spatial expansion and depletion over time. There was difference in social services among the study sites (Table 12) with a direct and indirect relationship between distance of the study sites to social services in term of business turnover and prices of the resource.

Table 12. Situation of social services (Key: \checkmark = Present; x = absent; P = permanent; S = seasonal, I = informal; F = formal)

(A) Socio services	Kunduchi	Buyuni	Magemani	Kitoni
Roads (P/S)	\checkmark P	\checkmark S	\checkmark S	\checkmark S
Water supply	\checkmark	Open well	Op well	Op well
Electricity	\checkmark	x	\checkmark	x
Dispensary	\checkmark	\checkmark	\checkmark	x
Fish market	\checkmark	x	x	x
Bank	\checkmark	x	x	x
Schools	\checkmark	\checkmark	\checkmark	x
Loan / credits (F/I)	\checkmark F&I	\checkmark I	\checkmark I	\checkmark I

The greater the distance of the study sites or fishing sites to the largest cities and market the poor and less the development of the sea cucumber fishery. There was evidence from old fishers that newer fisheries of sea cucumber were developing more rapidly over time in relation to when sea cucumber fisheries began and the ease to access markets and other social services. Although some social services e.g. loan and credits are offered locally and informally by local rich fishers and non-fishers, fishers expressed their dissatisfaction to the lenders large interests. In villages where NGO and Government banks are available, fishers were dissatisfied by conditions on getting loan. Presence of Savings and Credit Co-operative Society (SACCOS) and bank in Kunduchi, have made some sea cucumber fishers to develop behaviour of saving some portion of income during the peak season, which they withdraw during the lean period. However fishers expressed the difficult for them to lend money from bank due to lack of security and other bank rules unsuited to them, factors which make fishers stick to the middlemen as their creditors because they are familiar with their local situation than banks and given that middlemen are familiar with banking rules. Dependence of fishers to informal credits cause disadvantage of low beach price and perpetual indebtedness.

In Kitoni and Magemani there is cheap availability of large and high value species due to MPA such that in peak period, the fishers earn enough / sufficient and some fishers are able to serve for lean period. Some fishers who can't serve for lean period have to resort to other supplementary activities e.g. construction activities of hotels. The diversity of activities / opportunities depends primarily on the roads which allow for other non-fishers investor activities e.g. hotels, shops, transports to provide employments and loans to fisher. For sites with no infrastructure there is few supplementary activities like Buyuni village, fishers borrow money from boat owners and recover it during the peak period.

Access to credits is a major issue in areas away from cities and is linked to lack of education e.g. on various fishery issues e.g. empowerment, loan and credits educations. Although transportation is an important sector in the economy of the country and the Coastal villages, the majorities of study villages' roads are either paved or unpaved such some of the coastal villages are not interconnected with a good road network. The micro-finance continues to be made available by informal credits lenders to the sea cucumber fishers, sustainable practices should be strengthened. For beche-der-mer exporters, are dissatisfied by relatively high taxes on fish exports and financial services tend to constrain development of the sea cucumber fishery sector, and credit remains scarce in the fisher villages. However increasing global demand for tropical sea cucumber products could be an incentive to any sea cucumber fishers and investors in the sector. This could subsequently allow the fishers and the fishery to gradually move away from over-dependence on informal money lender. Some fishers complained weakness in financial credits and loan institutions sectors. For financial institutions (banks, saccoss and other rich informal borrowers) the main reason why credit markets are more problematic is that lenders and borrowers are not sure about the ability of the fisher to pay back the loan, both with respect to the expected outcome and with respect to the variation of the fishers' income. Lenders face an adverse selection problem. However, given the adverse selection issues, which have troubled small scale formal and informal credit schemes, there should also be some attempt to target those fishers who are most likely to use the invested funds successfully. Borrowers suggested fishery and socio-economist to be involved in fishers' projects so as to help fishers in planning their fishery and paying back loans.

3.6.2. Source of energy to process sea cucumber

The processing of sea cucumber involves boiling and drying, which make use of boiling equipment and firewood. The study sites differed in settings and urbanization level hence varied sources of energy for boiling and drying the sea cucumbers. The processors use firewood from mangroves, bought firewood and charcoal from distant districts and regions. The urbanization cause higher price of the energy source and cost of processing sea cucumbers due to lack of near forests or firewood. The cost of fuel to produce 30 kg revealed variations (Table 13).

The fisher villages under study depend on different sources of energy, such as electricity, kerosene, charcoal, firewood and solar. Lack of alternative energy for processing sea cucumber, especially in rural areas has imposed severe demands on forest resources due to unsustainable harvesting of wood for cooking. Fuel wood and charcoal are the main sources of energy for most people in the coastal villages of Tanzania. The small-scale fisheries sector is however constrained by inadequate fuel and energy sources hence lack of

capacity for processing, storage and transportation facilities. The post-harvest fish losses due to lack of storage and processing facilities is higher in Buyuni and Magemani compared to Kunduchi and Kitoni. Due to differences in sources of energy the cost of sea cucumber processing differ from place to place. Ban of harvesting mangrove trees has raised the cost of processing in places where no other trees. Preparations of beche-de-mer in Tanzania usually include boiling and drying, a procedure which basically follow (FAO, 1990). Although no specific official document on the processing methods for each species, processing is mostly done by men although in some places (e.g. Mafia), some women (4 out of 56) and children were seen processing sea cucumber. Contrary to other countries especially islands e.g. Samoa out of 206 interviewed by Eriksson, (2006), 116 women were processing sea cucumber. Source options and costs of fire woods and total costs for processing equipment and drying sea cucumber vary from site to site motivating collectors and processors to sell fresh sea cucumber direct to exporters there by eliminating the middlemen and bulkier roles. Local differences in processing sea cucumber in Tanzania were observed due to difference in level of knowledge among processors and sources of energy. Tanzanian coastal fishing community is characterised by seasonal increase in population due to seasonal immigrants, lack of electricity, poor water supply, ineffective education and poor economic opportunities as it has been described by Underson and Ngazi, (1998).

Table 13. Energy source options and total costs for processing / drying sea cucumber

Firewood sources	Kunduchi	Buyuni	Magemani	Kitoni
Solar	X	X	X	X
Mangrove trees	x	√	√	√
Mangoes trees	x	√	x	√
Coconut tree parts	x	√	x	√
Cashew nuts trees	x	√	√	√
Wood charcoals	√	√	√	√
Production costs of 30kg	40 USD	4 USD	32 USD	3.2 USD
Processing cost remarks	Very expensive	Very cheap	Expensive	Very cheap

3.7. Sea cucumber species, products price and values

The price of beche-de-mer varies greatly among species and also within species depending on the preparation standards of the animal (Table 14 a). The second highest-valued export commodity within the studied sites, sea cucumbers are among the few resources that can deliver profits at the village level (Table 14 a, b). Larger animals generally command a higher price per kilogram than smaller ones. Some tropical species, particularly the sandfish *Holothuria scabra* and teatfish *Holothuria nobilis* can fetch good price for large, well-processed specimens.

Table 14 (a). Price differences in whole selling and selling by species prices

Species	Grade	Amount (kg)	Sold wholly at	Sold by species
			8000/= /kg	prices Tsh. (USD)
<i>Holothuria scabra</i>	D	1.7kg	13,600/=	18,700/= (12)
<i>Holothuria nobilis</i>	B	1.5kg	12,000/=	11,000/= (7)
<i>Actinopyga milliaris</i>	C	3.3kg	24,400/=	50,000/= (32.3)
<i>Actinopyga mauritiana</i>	B	1.1kg	8,800/=	8,000/= (5.2)
<i>Actinopyga echinite</i>	B	8kg	64,000/=	40,000/= (25.8)
<i>Thelenota ananas</i>	C	11kg	88,000/=	142,000/= (91.6)
<i>Holothuria edulis</i>	C	1kg	8,000/=	500/= (0.3)
<i>Bohadschia vitiensis</i>	C	0.35kg	2,800/=	525/= (0.33)
			221,600/=	270,725/= (USD
Earning / weeks		27.95kg	(USD 143)	175)

Exchange rate USD 1 = Tsh 1550/= (N:B; the middlemen sells per week)

Table 14 (b). The comparison of the species prices per kg in some WIO countries (USD /kg)

Species	Grade	Tanzania	Indonesia	Malaysia
<i>H. scabra</i>	D	0.7	1.3	10.53 - 38.84
<i>H. nobilis</i>	B	4.7	6.35-10.59	18
<i>A. milliaris</i>	C	9.8	6.38-7.65	17.11
<i>A. mauritian</i>	B	4.7	8.03-9.88	-
<i>A. echinite</i>	B	3.2	6.38-7.65	-
<i>T. ananas</i>	C	8.3	7.06-9.41	17.11
<i>H. edulis</i>	C	0.3	0.41-1.32	-

Exchange rate; 1US\$ = 1550/= Tsh.

General poor stock status of sea cucumbers and transport problems influence exploitation strength and sea cucumber marketing particularly in Buyuni and Kitoni.

The presence and diversity of species vary by areas and are determined by habitat type, so target species vary by fishing area. Fishing in the past targeted mainly the medium and high value species but this has changed as high value species become overexploited and fishing effort shifts to the low value species. For the community of studied villages, sea cucumbers represent an important fishery and, if managed properly, has the potential to significantly improve economic conditions in the areas.

There was violation of some steps on processing methods and procedure as compared by official procedures (Desurmont, 2003) which lead into poor quality of beche de mer from Tanzania giving room for buyers to manipulate prices at selling stations. The comparison of the species prices per kg in some WIO countries (USD /kg) showed discrepancies which create more poverty and allow rich non-fishers (exogenous) to go higher in the sea cucumber fisheries as explored from a number of perspectives. This looks the same to other studies e.g. Bene (2003). Other reason for price difference was processing costs; handling procedures and care taken during processing, markets price, lack of knowledge of species price otherwise some middlemen manipulate prices, ease or difficulty of collection which control time spent in fishing depending on gears and vessels used, dependency level to the fishery of the household and lack or presence of other occupations to generate income.

3.7.1. Diversity of species and products

The way sea cucumbers are valued can be equated to the number of products produced, e.g. in Tanzania the product is only beche de mer (Mgaya *et al.*, 1998); in Madagascar, China and Pacific islands there are three products (Mc-Elroy, 1990; Chen, 2004; Eriksson, 2006; 2012; King, 2007; Choo, 2008), Korea and in Japan four products are available (Akamine, 2004; Baine and Choo, 1999) while in Malaysia there are six products (Mc-Elroy, 1990). Some low-value species or animals poorly processed would sell for a small fraction price.

Sea cucumbers are used in a wide range of products (Table 15) in different countries including oral jellies, body creams, shampoo and toothpaste in Malaysia and others in other countries (Choo, 2008a). Because they are a luxury food item and one that apparently delivers curative benefits, it is unlikely that the global market will wane over time, particularly if consumer affluence in China continues to rise.

The product in Tanzania is only beche de mer for export and no other use (contrary to other beche de mer producing countries e.g. China, Japan, Madagascar, Korea and Pacific islands where several products are produced from sea cucumbers) for subsistence and artisanal purposes (Mc-Elroy, 1990; Baine and Choo, 1999; Morgan and Archer, 1999) and hence more utility and income. There is no reinforcement or regulations governing the marketing. The obvious implication is that those who are unable to alter production due to reasons such as geographical location, access to credit, or lacking title to their property continued to produce traditional beche-de-mer and will not be able to escape poverty. This finding reaffirms that markets-led fishery must be accompanied by appropriate social programs or institutional reforms directed to the unique situational problems of different subgroups (collectors, processors, bulkier, middlemen and exporters) in poverty.

3.8. Perceptions of fishers on the stock status

Most of small scale and traditional fishers who used traditional methods are aware of depletion of large sea cucumber on the near-shore such as Kunduchi. Other sites e.g. Buyuni and Magemani were encroached after depletion in other shallow habitat. Fishers were starting to change their methods from wading in the shallow waters to the use of paddled canoe and motorized boats with non-selective fishing until the ban imposed in 2006. A broad-scale assessment of the stock at the landing sites and perception of sea cucumber fishers on state of sea cucumbers stocks confirmed different levels of depletions.

Large sized individuals are caught at Kitoni only, others site like Kunduchi, Buyuni and Magemani are dominated by small sized individual. Figure 7 shows difference dependence on the status of the stock although in some cases it depend on the hours and time spent in searching for certain species or the distance travelled to find the animals (in terms of boats) far in the deep waters.

Table 15. Number of products obtained from holothurians in Tanzania as compared to other producing countries: √ = existing; x = do not exist

Countries	Consumed		No. of Products	Products names	References
	Raw	Processed			
Tanzania	X	X	1	Beche-de-mer	Mgaya <i>et al.</i> , 1998; Mbaga, 2002
Madagascar	V	V	3	Beche-de-mer	Mc-Elroy, 1990
Malaysia	X	V	6	Trepang, Gamat oil, Gamat water, Medicinal balm, Tooth paste, Soap	
China	V	V	3	Trepang, Traditional medicine, Tonic food	Chen, (2004)
Korea, Japan	V	V	4	Beche-de-mer, Konowata, Kuchiko, Konoko	Akamine, 2004; Baine and Choo, 1999.
USA	X	V	2	Beche-de-mer Clam substitute	Morgan and Archer, 1999.
Pacific islands	V	V	3	Extract internal organ (Ngime) and return the animals to the sea to regenerate organs and later harvest them for Beche-de-mer and fertilizers	Eriksson, 2006; 2012 King, 2007, Choo, 2008

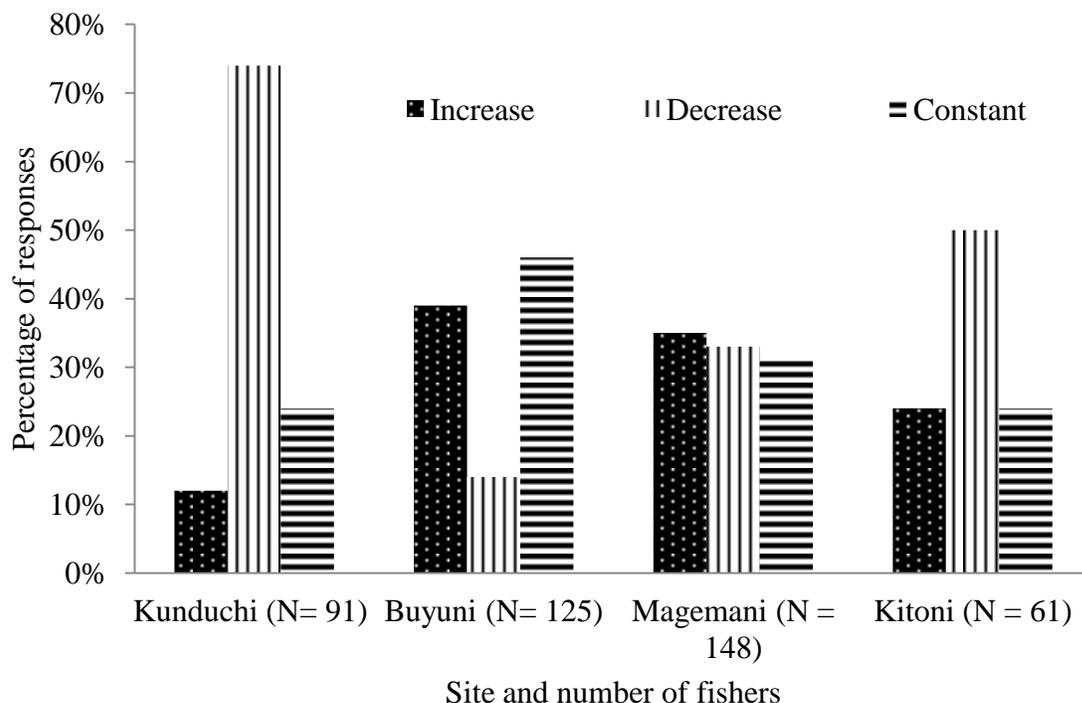


Figure 7. Perceptions of fishers on state of sea cucumbers stocks.

The perception of some fishers is that depletion is caused by immigrants which is also the case in other countries e.g. Samoa where majority of interviewed fishers claimed that catches, or availability of sea cucumbers, are declining along with an increasing number of immigrant fishers (Eriksson, 2006) such that the increased export data recorded by the government does not benefit the local fishers. The same cases have been reported elsewhere e.g. in Solomon Island 1988-2004 and closed in 2005 (Friedman *et al.*, 2008), Tonga 1997 closed the fishery for 10 years like in Samoa, Vanuatu and Warrior reefs and Torres Strait which was closed for 6 years and opened in 2004 (Friedman *et al.*, 2008). The same claims were put forward in Ecuador during the ban and authorities decided to open fishing of sea cucumbers, mainly due to social and economic considerations (http://www.enn.com/top_stories/article/1673; visited in 2012).

The traditional procedure of production was that collectors sold to processors who sell the processed product to middlemen e.g. in Buyuni and Kitoni while locations close to towns / exporters e.g. Kunduchi and Magemani collector have started to process their catch and bulk and sell their product direct to exporting companies. In some areas no cheap fire woods hence the catch is sold unprocessed to exporter (e.g. Kunduchi and Magemai).

3.8.1. Responses of fishers to the depletion of sea cucumbers in the study sites

In places where fishers have never gone to deep areas do not agree that there is depletion of the resource but lack better equipment to go to deep areas or far water and therefore prefer shifting to other grounds. Very few prefer quitting the fishery. The action likely to be taken by fishers also differed (Figure 8).

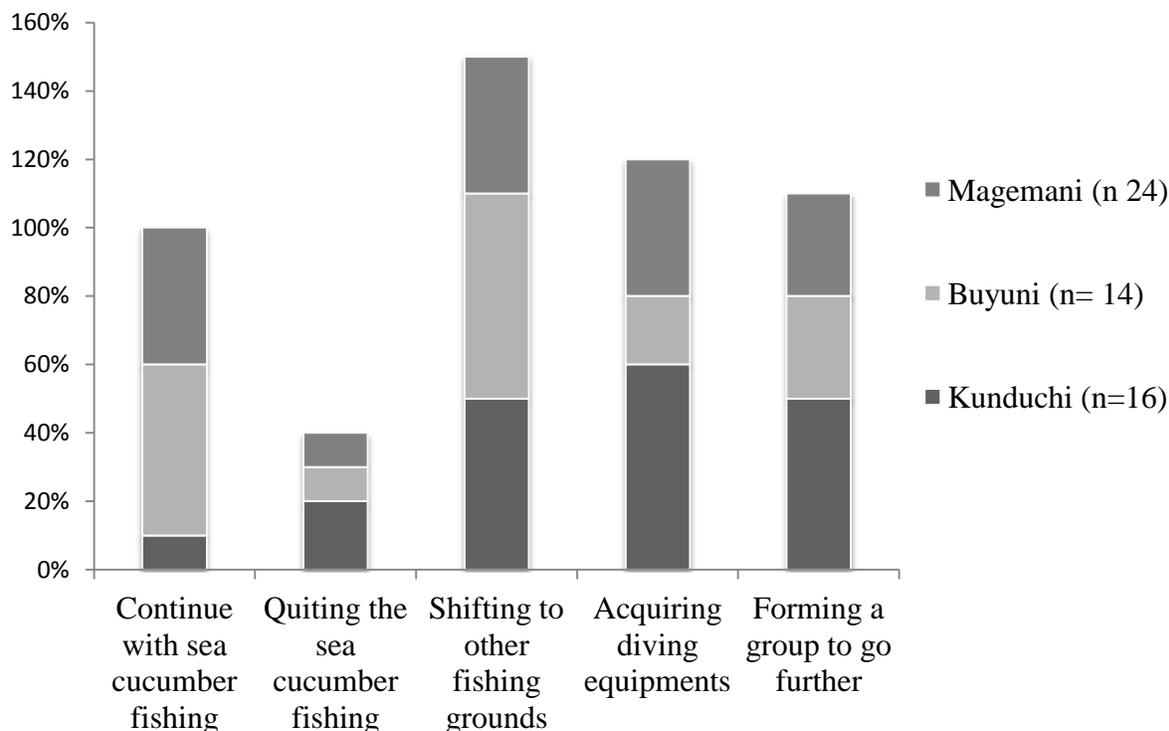


Figure 8. Fishers’ responses to 5 hypothetical scenarios of declining or depletions of stock

4. Conclusion

It was observed in this study that as the sea cucumber is depleted in shallow water, or in an area (as a Boom and bust cycle), each group want to gain more than the other; (i) The rich people want to benefit by hiring poor young fishers and move to deep water leaving behind old men, women and children. The rich people (mostly non-fisher) owning fishing boats, diving equipment (SCUBA) and hire divers to collect sea cucumbers. Hence fishers with low capitals in the study sites blame the ban implemented by the government arguing that if no enforcement it is in favour of rich businessmen. (ii). The lowly income fishers claim that not all sites are depleted by all species so the government was supposed to involve sea cucumber collectors’ team to establish the ban the way they know the fishery. Unfair competitions for the resource lead

to weakening of local system used to control the resources by local leaders, embracing of migratory fishers by some village authorities with thriving of illegal activities. (iii). There is also denial of credit facilities and price manipulations done by middlemen and agents. With such ban and weak regulation enforcement as well as high income inequality there are less ban success and fishers failure to withstand economic loss. There are senses of injustice done by leaders in favours of greedy immigrants. The current total moratorium of the fishery does not work as no dialog was done with the other part of Tanzania (islands) such that illegal collectors are now selling their harvest to Zanzibar. There is need to re-address the sea cucumber fishery especially the dialogue with Zanzibar in the methods of regulations and specific geographical location-fit management, dialogue with buyer countries on beche-de-mer species quality and fair prices so as to promote efficient performance of the fisheries in different locations; establish fishing regulations that are specific to sea cucumbers in terms of size of harvest (catch), gears and methods of collection.

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