Coral Reefs: Values, Threats, & Solutions.

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Socioeconomic Impacts of Coral Destruction on Unguja Island, Zanzibar, Tanzania.

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INTRODUCTION

Coral reefs are important ecosystems that support a variety of marine life. The coral reef ecosystem is both a nursery and feeding grounds for a variety of economically important finfish, shellfish and mollusc species. Coral reefs are known to reduce the extent of coastal erosion although there have been some arguments on this (Fay 1992, Nyandwi and Muzuka 1991, Francis et al 1997). Ocean waves that break on the reef become less strong when reaching the shore. The coral reef front is generally under strong hydrodynamic conditions due to breaking of waves on the reef (Joottun 1994).

The corals and coral reefs of the Zanzibar Islands are still in better condition compared to reefs in other countries. Coral reefs of Kenya for instance, are said to be more than 50% in either fair of poor condition, a situation that is described as a dramatic decline from just a decade ago (Okemwa and Wakwabi 1993). However, population growth, overfishing and the increase in tourist activities are becoming threats to the corals and coral reef. Zanzibar population has increased from 264,200 in 1948 to 792,000 in 1995. It has been estimated that with 3% growth rate, the population of Zanzibar will reach 1,488,000 by the year 2015 (Department of statistics 1993). Zanzibar may in the near future agree with Mathus' late 18th century fears of population outgrowing resources. In 1991 Zanzibar produced a Tourist Act to promote tourism as one of the alternatives to the declining economy resulting from the falling price of clove in the world market. Since then, the number of tourists visiting the Islands has increased fast from 16,268 in 1985 to 56,415 in 1995. In 1996 the number of tourists visiting the Islands was 69,159. The number of tourist hotels has equally increased. Small unplanned tourist towns have started developing all around the coasts and especially the east coast. As is the case with Mombasa (Mwaguni and Munga 1997), there are no sewage or solid waste treatment facilities. Structures put close to the shores increase the rate of erosion and pollution of the marine environment. The tourist hotels, guest houses, snack bars etc. are threats to the environment. If the beach or shoreline is eroded, the ultimate destination of the sediment is the coral reef ecosystem. Pollution from sewage, solid waste etc., caused by such coastal structures will eventually pollute the coral reefs.

Boats operating in the coastal areas be it fishing, passenger, cargo, or tour operators boats are a threat to the coral reefs. Possible threats from the boats include the use of destructive fishing methods, anchoring of boats on the reef, trampling by divers and snorkers, accidental oil spills, flushing of tanks, solid waster disposal and sewage disposal. When all these activities continue to operate, and increase in the rate and number, the coral reef becomes the sinker for pollutants.

Polluted corals cannot grow properly. Corals are very sensitive to pollution and suffer decline in population densities and biodiversity. Formation of the reef is, therefore, affected.

Fish catches in Zanzibar have been decreasing while life expenses have risen (Mmochi et al 1997). Also, prices of fishing gear have increased so much that most artisanal fishermen cannot afford (Msuya 1996, RIPS 1995). These factors have forced fishermen to go into using destructive fishing methods such as dynamite fishing, poisoning, spearing, the use of fishing nets with small mesh sizes and surrounding nets known locally as Kigumi.

The activities affect marine life in the coral reefs. Nursery and feeding grounds of fish are destroyed leading to decrease in fish catches. The socioeconomic impacts to the Zanzibar population that depends

mostly on the sea become predominant.

This study was conducted on Unguja Island, Zanzibar, in February/March, 1997. It was aimed at looking into the socioeconomic impacts of coral destruction.

MATERIALS AND METHODS

Interviews were conducted to 43 members of societies on Unguja Island. A questionnaire used for UNESCO study on coastal erosion (Francis et el 1997) was modified to suit this study. The new questionnaire had 14 questions all concerning corals, coral reefs and associated resources. Codes were prepared for the respective questions depending on the need of the study and experience gained in field conditions.

Face to face interviews were conducted in coastal villages/areas where respondents' answers were filled in the questionnaires. Respondents targeted for interviews were all adults with different occupations and interests. Arrangements were made with the local leaders of the areas and villages. Coding of the questions was done after interviews in the particular day. Informal discussions, life history, *in situ* observation and the use of key informants were part of the methodology. Areas where interviews were conducted are Nungwi, Mkokotoni, Zanzibar Town, Chwaka, Uroa, Marumbi, Paje, Jambiani, Bwejuu, Makunduchi, Mtende, Kizimkazi and Bweleo.

For the purpose of getting relevant information the following aspects were covered:

a) whether the respondents knew anything about corals

b) what is the source of knowledge on corals?

c) what changes on the corals or coral reefs were observed?

d) what are the causes of such changes?

e) what are the impacts of the changes?

f) what efforts have been made by the people to reduce the impact?

g) what activities/resources have been affected by destruction of the coral reef?

h) what are personal comments on what should be done?

i) what alternative economic activities can be done when those that are dependant on the reef are no longer feasible?

j) are there traditional legislations on coral reefs and associated resources that exist in the community?

k) what does one think is the role of the government?

RESULTS AND DISCUSSION

Respondents' awareness on Corals and Coral reefs

In all areas throughout the Island, people knew about corals and coral reefs. Percentage of people who answered yes to the question on whether they know about corals was 72%. The people were very knowledgeable considering that most of them have been living at the coast for long. They have also been directly involved in the sea which they depend for their livelihood. Such advantages increased their capacity to know more about corals and coral reefs. Fishermen, however, knew much more about issues that are directly related to coral reefs than the other members of the society. The percentage of fishermen who knew about corals was 88% as compared to 68% for the rest.

Age, educational background and length of stay at the coast

The results on analysis of the relationship between age, educational background and length of stay (years) at the coast showed that there were differences between the groups. In the analysis people who answered more than 50% of the questions were considered as the most knowledgeable. Generally, older people (above 50 years) knew more about corals than the younger ones. This reflects their long experience with the sea.

As for the educational background there is no direct relationship between observations on the corals and level of education. However, the most educated people knew a lot about logical issues and what they learnt from school. A respondent who mentioned the use of biological methods of conservation like the removal of sea urchins had a BSc in biology. However, she knew little of practical changes taking place in the reefs. Among the fishermen, though not educated, majority knew much about practical physical changes that are taking place in the reef. They could give a reflection on for example the link between coastal erosion and coral destruction by explaining that the sediment is carried and deposited on the reef. They were also very knowledgeable on impacts of destructive fishing on the coral reef.

There was a direct relationship between the length of stay at the coast and the amount of knowledge. People who have stayed longer at the coast (about 20 years) knew more than those whose stays were shorter. Most of the people saw the changes taking place during their stay at the coast.

Sources of knowledge

Practical observations were the most mentioned source of knowledge on the changes taking place on the reef (Fig. 1). Most respondents have been living at the coast for a long time observing changes that have been taking place. A smaller percent of people mentioned that they learnt about changes not only from practical observations but also from friends and relatives (18.6 %), school (9.3%), radio and television (4.7 %) and seminars (2.3 %). Younger respondents mentioned that they ask their elders on how it was in the past. This was common to respondents who are not fishermen.

There are also some who mentioned that they learnt about changes taking place from "experts" who visit them. These "experts" are mainly extension officers and researchers.

Changes observed on the reef

Most people in all the areas surveyed observed coral breakage as the main change. Coral breakage scored the highest frequency in the Unguja societies (98%). Decreased coral fish catches and varieties appeared as the second (77%) most frequent observation made on the reef. Other observations were increased turbidity of the water in the coral gardens, increased deposition of sediment, reduction of coral diversity and increased wave power at the reef. Fishermen whose fishing occupation is directly related to the reef observed

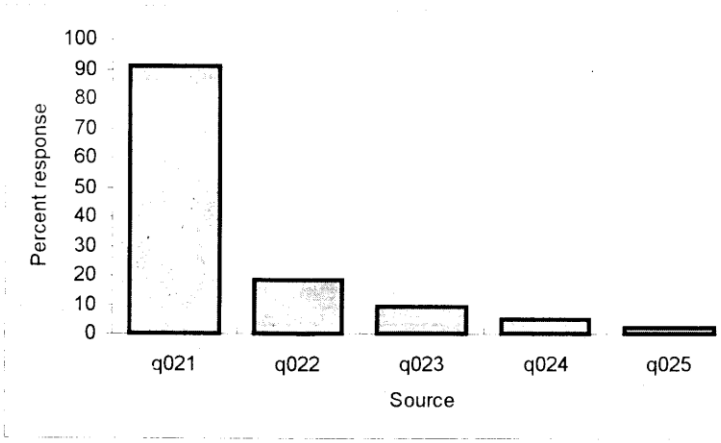


Figure 1. Sources of knowledge on corals and coral reefs. *q021* Practical observation; *q022* Friends & relatives; *q023* School; *q024* Radio, TV, & printed media; *q025* Seminars & workshops.

coral breakage more frequently. Few people also mentioned breakage of octopus caves.

At Nungwi in the northern tip of the Island, and Chwaka Bay in the east, people mentioned that because of destruction of coral reefs, erosion has become severe and the shapes of the Ras Nungwi and Ras Michamvi peninsular have changed.

This awareness on actual physical changes taking place on the reef is quite high compared to other countries such as Kenya where only 50% of the coastal population were aware of the coral destruction problem (Mwanje 1997).

Causes of the changes

The most frequently mentioned cause of coral destruction was destructive fishing methods especially dynamite fishing. Destructive fishing methods such as dynamite fishing, spearing, poisoning, small meshed nets and Kigumi ranked highest among all respondents (79%). The second highest cause of changes in the reef was boat anchorage. Anchors used by fishermen, tour operators and other boat users break corals when boats are anchored on the reef. Other causes of coral destruction included trampling by divers, sedimentation, increased turbid water and shell collection. Although they do not know details of light penetration and coral growth, respondents mentioned that increased turbid water on the reef kills the corals. Corals need very clear water for proper growth. A good light intensity and penetration are important for photosynthesis, a crucial aspect of coral growth. If the water becomes turbid, coral growth is inhibited.

Mangrove deforestation has been mentioned as a major cause of coral destruction. Mangrove deforestation ranked the second highest cause of coral destruction (63%), among the respondents. Mangroves provide a protection against erosion. Indiscriminate cutting of mangroves allows ocean waves to reach the shore and erode the shoreline. The eroded shoreline, beach and mangrove sediments are carried by the waves to be deposited on the coral reefs. Deposition of sediment reduces light penetration affecting growth of corals. Formation of the reef is, therefore, affected.

Coastal erosion has been blamed by 32% of the respondents for destruction of corals. Erosion that results into movement of the sediment has been mentioned as a cause of sediment deposition on the reef. Coastal

erosion also leads to increase in water turbidity in the coral reefs.

Divers (and snorkelers) have been blamed for breaking corals. Costumes worn by the divers may trample the corals breaking them. Divers can also step on the corals thus breaking them.

Shell collection is another cause of coral destruction that was mentioned by the people. Usually some people dive in coral reef areas to collect shells that are sold for decorations (ornamentals). At Nungwi, villagers mentioned that they are sure that they contributed to the destruction of the coral reef resulting into severe erosion in the area. They mentioned that in the past, people used to break corals in order to get valuable shells for selling. These shells were sold to businessmen who came to buy the shells in the area. Coastal erosion in Ras Nungwi is very high. It has been estimated to be about 1.3 km per year (Nyandwi and Muzuka 1991). During the interviews the people said they were regretting much about what they did in the past. Now, they said, they have realised their mistake and will do everything possible to reduce the effects.

Activities of fishermen other than the use of dynamite, poison, spear and the like, were mentioned as causes of coral destruction. Breaking of octopus caves was mentioned as a result of careless hunting of Octopus. Solid waste from fishermen boats and the rowing poles affect corals. Some people who were not fishermen, (but had secondary school education), pointed out that fishermen were "told not to break corals" but they do not follow orders.

A few people, however, thought that despite the destruction of the reef, sea level rise is a natural process brought by God (2%). Following the idea, these respondents thought that nature should be left to take care of itself, and that may be the situation will change with time, when God wishes. No fisherman mentioned that nature should be let to take care of itself.

The increase in seawater level on the reef was mentioned as a cause of reef destruction by reducing the efficiency of coral growth. Corals need shallow waters for proper growth to allow light penetration. If the level of the water increases to the level of reducing the amount of sunlight reaching the corals, growth becomes poor. Joottun (1994) pointed out that if the seawater level is high and coral growth could not keep pace with the change, their growth will be retarded.

A combination of causes is responsible for coral reef destruction as observed in this study. Mwandoto (1997) observed similar causes of coral reef destruction in Kenya. The author reported that overfishing and excessive sea urchin population, siltation from dredges, damage from tourists and boats, and land-based sources of pollution all contribute to reef degradation.

Impacts of Coral destruction

Destruction of corals and coral reefs causes a lot of problems to the people and their environment. The first impact that received the highest frequency among the coastal dwellers of Unguja Island was the rise in sea water level because of destroyed reefs (98%). Respondents pointed out that ocean waves have become stronger and the sea water has destroyed coastal properties such as trees, (coconut and pine), houses and land. The strength of ocean waves has been observed also on Pemba Island and Mainland Tanzania. Francis et al (1997) mentioned that the strength of ocean waves has increased recently and the blame has been on braking of coral reefs. A number of coconut and pine trees that used to be far from the shore have been eroded away. Some coastal houses have been abandoned because of seawater intrusion. At Mkokotoni, rice fields have been abandoned because seawater has entered the fields. Boreholes in the village are becoming increasingly saline.

Reduced fish catches was the second most frequent effect mentioned by the people followed by disappearance of some fish species and lastly destruction of nursery and feeding grounds. Percent of people who are concerned about the impact was 79%. Experienced fishermen mentioned that destruction of the coral reefs has resulted in reduction in fish catches. Catches are nowadays smaller than in the past. People also

mentioned that some fish species have been reduced in numbers whereas others have disappeared from fishermen's catches. Some fish species breed and feed in the coral reefs. If the reef is destroyed their recruitment to stock is reduced and therefore, the catches decline.

Destruction of the coral reefs resulted into destruction of fishing grounds. Each village had specific areas where fishermen would fish. Following the destruction of the reefs some fishermen have been going to fish in other villages. The intrusion by visiting fishermen was mentioned to be a serious problem in Makunduchi, Bweleo, Mtende and Nungwi, Chwaka and Marumbi. It is difficult for villagers to control fishing methods used by visiting fishermen. Most visiting fishermen are said to be using destructive fishing methods.

Fishermen are forced to go far from their normal fishing areas in order to get some catch. This was a concern for many people, both fishermen and the others. Those fishermen who cannot go far because of type of boast, gear etc. get minimal catches. Fishermen in the southern regions of Mainland Tanzania have to travel up to Mozambique in order to get satisfactory catches (Msuya 1996).

Few people said that destruction of the coral reefs has caused erosion that has reduced the beauty of the beaches. These people worked in guest houses/hotels.

Efforts made by the people to reduce the impacts

Societies on Unguja Island have been trying to reduce the impacts of coral destruction. Impacts were reduced by three main options that received similar frequencies. These are to ban destructive fishing, to ban removal of corals from the sea and to plant vegetation. In all the villages, respondents said that the use of destructive fishing methods is not allowed. This is a customary law usually agreed among the villagers themselves and each member of the society is required to follow it. Destructive fishing is illegal in Zanzibar and the government has stated so in its fisheries policies and marine conservation and environmental laws. People have tried to plant vegetation along the shore including pine trees and climbers known locally as "Mila kasa". Some vegetation have been successful whereas others have proved futile. Planting of "Mila kasa" was common in Paje, Uroa and Jambiani. Other options used were to educate each other, to encourage community participation and to follow existing fishing regulations. A very small percent (2%) said that they should let nature take care of itself. However, 40% have not done anything. In some villages, people have realized that coral reefs have been overfished and so they use closed fishing seasons. This is practised in Bwejuu, Paje and Jambiani. In some villages, people have formed community-based committees for protection of the environment. Such committees were in Kizimkazi, Bweleo and Mtende. Some villagers said that they reported any destructive activities that they see to responsible departments such as fisheries and forestry.

Community-based legislations

Among the most practised community-based legislations are to forbid the use of destructive fishing methods and picking of corals from the sea. These were the most frequent legislations that scored 78% and 89% respectively. Other legislations include controlling entry of visiting fishermen, use of closed fishing seasons and planting vegetation on the shoreline. Visiting fishermen have been blamed because of the habit of using destructive fishing methods. Concerns were raised at Makunduchi, Kizimkazi, Bweleo and Mtende on the destructive nature of visiting fishermen, who camp in these villages or at small islands. Some are said to camp at the islands for up to eight months.

Effectiveness of the legislations

Community-based legislations are generally effective ranging from very effective (25%) and moderately effective (27%). However, 23% said that there was little effectiveness, whereas 5% said they were not effective at all. 12% said that there were no community-based legislations in their areas. These respondents may not be knowing the legislations but would prefer saying "no legislation" to "I don't know". In most areas

on Unguja Island there are community-based legislations. This is also common in coastal areas of other countries. Mwanje (1997) observed that in Kenya community-based legislation existed in most coastal areas. Some people mentioned that community-based legislations do not get much support from the government rendering them less effective.

Suggestions on what should be done to reduce the impact of coral destruction

Suggestions on what should be done to alleviate the situation showed that majority (63% and 44% respectively) mentioned that people should stop using destructive fishing methods and picking corals from the sea. Other frequent suggestions are community education, to follow existing regulations and to encourage community participation in the conservation of the corals and coral reefs. More than half of the respondents (51%) mentioned that the government should take care of the situation because people are too poor to implement any effective measure. At Jambiani, south east coast, some people mentioned that communities should form by laws that will help to reduce destruction of coral reefs. In some villages, people suggested that community based environmental committees be formed. Few people who worked in tourist hotels/guest houses mentioned that it is important to discuss with fishermen and advise them not to break corals when they are fishing. Others pointed out that legislations should be enacted where none exist and that those already in place should be followed properly. Okemwa and Wakwabi (1993) mentioned that corals and coral reefs can be managed by increasing effectiveness of the existing laws and regulations.

The role of the government

When the respondents were asked to what they think is the role of the government, the majority (77%) mentioned that the government should punish violaters of the existing laws. Some mentioned that the government should guard corals and other coastal resources. Another role mentioned by some respondents (14%) was to set up to-date legislations. It was pointed out that some existing laws are out of date and that they should be revised. Other government roles mentioned were that it should conduct patrols in the sea and educate the people through mass media and meetings. To give motivation to people who took self initiatives to conserve the marine environment was mentioned as another role of the government.

Comparison between fishermen and people with other occupations

Awareness on corals and coral reefs

The percentage of people who knew much about corals was higher among fishermen (88%) than the others (68%). The results conform with the idea that fishermen work directly in the coral reefs. During their fishing occupation, they always work near or at the coral reefs. The smaller percent of the other people who know about corals reflects their differences in occupations that are not directly related to the sea or coral reefs. Occupations other than fishing and fish trade included government employees (e.g. village leaders, extension officers), farmers, petty traders, teachers, hotel/guest house workers etc.

Observations made on the coral reefs and associated resources

When fishermen were compared with the other members of the society, (Fig.2), the percent of fishermen who observed coral breakage was 100% whereas for the others it was 94%. Percentage of respondents who observed decrease in coral fish catches and varieties was almost equal but fisherman percentage was higher (73% and 71%). Higher percentage of fishermen also observed increased turbid water in the reef. However, those aspects that were not directly observable were not much familiar to the fishermen. Issues such as reduced coral varieties, increased sediment deposition, increased wave power at the reef were more observed

by non-fishermen. Whereas 7% of the others said they did not know of any changes, no fisherman said so.

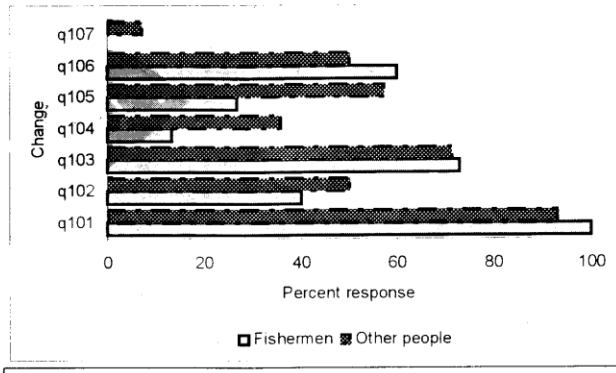


Figure 2. A comparison of changes observed by fishermen and other members of society. *q101* breaking of corals; *q102* decreased coral variety; *q103* decreased fish catch & fish variety; *q104* increased wave energy; *q105* increased sedimentation; *q106* increased water turbidity; *q107* unkown.

Causes of coral destruction

In response to questions, 24% of fishermen and 26% of the other society members mentioned sediment deposition, and 47% of the other members mentioned that coral destruction was a natural process and one cannot stop erosion from taking place (God's will). Only 35% fishermen mentioned natural changes as a cause of erosion. Percentage of the other people who said deforestation of mangroves is a cause of coral destruction was higher than that of fishermen. Other fishermen's activities that cause coral destruction were observed more by fishermen than the other members of the society whereas concern on destructive fishing was equally observed.

Impacts of coral destruction

A comparison between fishermen and other society members showed, a similar trend. In this aspect 100% of both fishermen and people with other occupations observed that seawater destroys properties near the shoreline. Whereas the disappearance of some fish species was observed by 77% of fishermen, only 42% of other members of the society observed this impact. This reflects the experience of fishermen who work directly on the reefs. Nobody in both cases said that he or she did not know of any impact.

Alternative economic activities

A question was posed to fishermen, middlemen, whole sellers and retailers working on fish trade as to what alternative economic activities they could do if fish got finished because of coral destruction. Whereas other stake holders had a variety of alternatives ranging from small scale enterprises, salaried employment, agriculture, migration to other areas, seaweed farming, tourism and animal husbandry, fishermen had fewer alternatives (Fig.3). Fishermen thought that if they cannot go into small-scale business they could do agriculture or go to areas where there are more fish to catch. The difference between fishermen and the others on migrating was that fishermen wanted to only go and camp somewhere so as to fish but not moving to stay

in such areas. The others said that they could move to such areas. Fishermen also thought that they could go into seaweed farming whereas the others did not think of that as an alternative activity. No fisherman said he could opt to salaried employment, tourism or animal husbandry. More than 50% of fishermen, however, pointed out that there is no alternative activity.

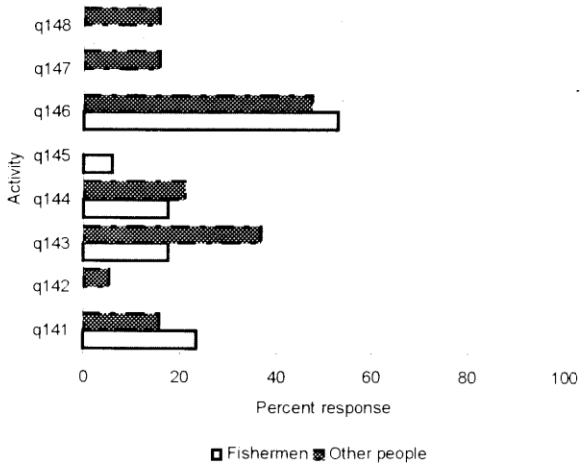


Figure 3. A comparison of alternative economic activities for fishermen and other members of society. *q141* small scale enterprises; *q142* salaried employment; *q143* agriculture; *q144* migrate to other fishing areas; *q145* seaweed farming; *q146* none; *q147* tourism; *q148* animal husbandry.

CONCLUSIONS

Most people on Unguja Island know about corals and coral reefs. Their knowledge is strengthened by their direct involvement in the sea and their long stay at the coast.

The main aspects that people observe as changes on the reef are breakage of corals, increased sediment deposition and decreased fish catches.

Destructive fishing methods and picking of corals/shells are activities that mostly destroy the corals and coral reefs. Deforestation of mangroves increases the rate of erosion that deposits sedimentation on the reefs.

Destruction of the corals and coral reefs has affected and continues to affect societies on Unguja Island. Being bound to the use of the sea, most people are suffering from impacts of coral destruction. The people lack alternatives as they are used to being dependant on the reef. Fish catches have decreased and erosion has lead to loss of coastal properties.

Fishermen know more about practical aspects of corals that are directly related to their occupation. Issues such as physical changes on the reef and changes on fish catches are more known by fisherman than other members of the society.

Community education, effective legislations and community participation are imperative to arrest the situation before it is too late.

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