



Natural resource dependence, livelihoods and development

Perceptions from Tanga, Tanzania

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Table of Contents

Acknowledgements	4
Acronyms and Abbreviations	4
Executive Summary	5
1. Introduction	7
1.1 Study location	7
1.2 Marine resource management and coastal community development	9
1.3 Study objectives	9
2. Methods	9
3. Results and Discussion	10
3.1 Coastal zone management and fisheries development programmes	10
3.1.1 Tanga Coastal Zone Conservation and Development Programme	11
3.1.1.1 Collaborative Management Areas	11
3.1.1.2 Capacity building within TCZCDP	12
3.1.1.3 Benefits to coastal communities from TCZCDP	13
3.1.2 IUCN Community Consultation Workshop	14
3.2 Dynamite Fishing	15
3.2.1 Impacts of dynamite fishing	15
3.2.2 History of dynamite fishing in Tanzania	16
3.2.3 Dynamite fishing along the Tanga coast	16
3.2.4 Legal context of dynamite fishing in Tanzania	18
3.2.5 Current initiatives towards control and elimination of dynamite fishing	18
3.2.5.1 Government Patrols	18
3.2.5.2 Community vigilance	19
3.2.5.3 Tanzania Dynamite Fishing Monitoring Network	19
3.2.5.4 Friends of Maziwe Island and Friends of Coral Reefs in Tanga	19
3.2.5.5 Recent government and donor action	20
3.3 Mariculture along the Tanga coast	20
3.3.1 Value chain analysis	21
3.4 Mariculture site visits in Tanga	23
3.4.1. Milkfish culture in Machui village	23
3.4.2 Crab and seaweed culture in Kiwavu village	23
3.4.3 Lobster aggregating devices in Kigombe village	24
3.5 Challenges facing mariculture production in Tanga	24
4. Conclusions	24
4.1 Dynamite fishing	24
4.2 Mariculture	25
5. References	28

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Acronyms and Abbreviations

BMU	Beach Management Unit
CMA	Collaborative Management Area
CMAP	Collaborative Management Area Plan
CORDIO	Coastal Oceans Research and Development in the Indian Ocean
CPUE	Catch per Unit Effort
EAME	East African Marine Ecoregion
EARO	IUCN Eastern African Regional Office
EAWS	East African Wildlife Society
EIA	Environmental Impact Assessment
FAD	Fish Aggregating Device
FAO	Food and Agriculture Organization of the United Nations
IMS	Institute of Marine Science of the University of Dar es salaam
IUCN	International Union for the Conservation of Nature
NGO	Non-governmental Organisation
SEEGAAD	Smallholder Empowerment and Economic Growth through Agribusiness & Association Development
SEMMA	Sustainable Environmental Management through Mariculture Activities
TCCF	Tanga Coastal Consultative Forum
TCMP	Tanzania Coastal Management Partnership
TCZCDP	Tanga Coastal Zone Conservation and Development Programme
TDFMN	Tanzania Dynamite Fishing Monitoring Network
TZS	Tanzania Shillings (currency)
USAID	United States Agency for International Development
USD	United States Dollar (currency)
VMT	Village Monitoring Team
WIOMSA	Western Indian Ocean Marine Science Association
WWF	World Wide Fund for Nature

Executive Summary

Numerous marine resource management initiatives have been implemented in East Africa over the last 15 years. However, success has been limited if poverty and natural resource health are used as indicators, although the capacity to manage marine resources has improved. This study seeks to map coastal peoples' perceptions of marine resource use and their dependence on these resources, changes in resource status, and what effect conservation and natural resource management have had on coastal peoples' socioeconomic development, in order to understand the bottlenecks to good governance of common pool marine resources. The Kiunga area in northern Kenya and the Tanga area in northern Tanzania were selected for case study analysis due to considerable conservation and management intervention in these areas over time. The findings of the Tanga case study are presented herein.

Tanga Region is situated in northern Tanzania bordering Kenya, with a population of over half a million people who are highly dependent on fishing as their main source of livelihood. Other livelihood activities include mangrove cutting and selling, salt making and tourism, all linked to marine and coastal natural resources. The objectives of the study were to compile existing information on the link between coastal peoples' livelihoods and marine resource management in Tanga, with a particular focus on two issues pertinent to the area: dynamite fishing and mariculture. The study was conducted in January 2008 and included a literature review, interviews with fishers, managers and other key stakeholders and field visits.

Locally implemented marine resource and fishery management programmes have in the past benefited fishers in Tanga, because these initiatives resulted in an improvement in the state of fish stocks and greatly reduced the incidence of destructive fishing methods, including dynamite fishing, at least for some time. However, since 2005 these benefits are being undermined by an escalation in dynamite fishing, which has evaded most efforts to curb it. Sadly, Tanzania's mainland coast now has a reputation for having the most damaged coral reefs in the region, with Tanga renowned as the most affected by dynamite fishing. This is likely to significantly undermine Tanzania's coastal tourism development plans.

Coral reef ecosystems have high biodiversity and yield highly productive fisheries. Dynamite fishing destroys the very basis of this system – the corals that build the reefs – leading to significant loss of biodiversity and fisheries productivity. The dramatic reduction in the abundance of fish that support Tanga's key coastal fisheries since 2003 is likely to be linked to the destruction of Tanga's coral reefs from dynamite fishing. The problem cannot be underestimated, yet the practice has resumed in spite of government led patrols, extensive campaigns from concerned citizens, and at times good local media coverage. It would appear that the nature of dynamite fishing is well understood by most stakeholders, including the government and various communities in the region. The failure to effectively tackle this pernicious practice may relate to an over-reliance on enforcement on water, which is difficult, expensive and many times inefficient. Placing more emphasis on also addressing some of the enabling factors, including e.g. easy access to dynamite and detonators, the financial backing provided to dynamite fishers, an ineffective judicial system and lack of transparency, may yield better results, and would also help build compliance. There may be lessons to learn from neighbouring Kenya, where dynamite fishing does not occur.

The destruction of Tanga's coral reefs and the loss in fishing livelihoods and revenue means that the development of alternative livelihoods for coastal communities is now even more pressing. This view was echoed in a national community lessons learning workshop held in Tanga in January 2008 (Becha 2008). Tanga Region has taken several steps to develop aquaculture among its coastal people, with three dominant mariculture initiatives evolving according to the different coastal habitats in the area: seaweed farming in the shallow waters off sandy beaches; crab fattening in mangroves; and milkfish pond farming in salt flats behind the mangroves. Communities have engaged in the practice largely due to encouragement and support from NGO driven programmes.

Since mariculture is still relatively undeveloped in Tanga region its impact on coastal peoples' livelihoods has not been assessed in detail. Certainly women have benefited from seaweed farming, which although limited, provides them with a cash income roughly double what they have might have earned from other

activities such as selling firewood, and the young men collectively running a crab fattening group venture in Pangani reported substantial improvements in their incomes. Overall, though, mariculture initiatives in Tanga Region are small scale, at the household or village level, and rarely provide more than a supplemental income, mostly due to the small scales of production, lack of physical and technical inputs, lack of suitable markets and financial/investment constraints.

Mariculture has great potential for addressing food security and income generation in the region. Substantial effort is now required to build capacity, provide technical inputs, and ensure small-scale mariculture in Tanga is developed through learning lessons from South East Asia and South America where the industry is 10-15 years ahead of East Africa. Notably, the fears of environmental damage from aquaculture and the associated onerous Environmental Impact Assessment (EIA) requirements in Tanzania relate to past problems that have largely been addressed e.g. through advances in technology and development of new approaches. However, technical capacity within District government to provide adequate extension services is limited, hardly surprising considering the fast pace of development in this industry globally. It is recommended that this situation be more broadly recognised and that government outsource mariculture extension services to e.g. Non-governmental Organizations (NGOs) or companies specialising in community based mariculture.

Further, quantitative assessment of whether mariculture has reduced pressure on marine resources by drawing fishers away from fishing is also lacking, and this important question can not be reliably answered with presently available information. It is highly recommended that well designed monitoring and assessment protocols capturing this are put in place as the number of mariculture ventures increase and the industry develops fully in Tanga Region.

It is also important to note that none of the existing animal-based mariculture initiatives in Tanga Region are true mariculture because they are not breeding the organism – there are no hatcheries in Tanzania. Instead all practices harvest organisms from the wild either as fry or juveniles, and therefore operate essentially as grow-out practices. This is relevant if the animal is already targeted in the local fishery, as the harvest of juveniles may negatively affect adult wild populations. Both crab and lobster are important target resource species, milkfish less so. The crab fattening cages and the lobster shelters (for aggregating lobster) should therefore be seen as mechanisms for either value adding to an existing fishery, in the case of crab, or for enhancing fishing efficiency, in the case of lobster. Consequently such practices should not be seen as separate mariculture industries as they are not independent, a fact that does not seem to be properly assimilated by most stakeholders in the area. With a careful approach that integrates sustainable management of fisheries and wild stocks as well as mariculture development in Tanga Region, the full potential of mariculture as a means for improving both livelihoods and environmental health can be realized.

1. Introduction

Sustainable use of biodiversity has significant links to human wellbeing and poverty reduction. More than 10 years after the 1992 Rio Declaration on Environment and Development, demographic trends, health epidemics and the pressing need to reduce poverty have strained natural resources and threatened to greatly diminish the world's collective biodiversity. These trends have serious implications not only for future poverty reduction and development, but also for the health and wellbeing of the human population today.

In Africa, millions of people depend heavily on the continent's genetic, species and eco-system diversity to support livelihoods, health and nutrition. Some 30 million people live in the coastal region of the Western Indian Ocean, of which eight million in Tanzania (Obura et al. 2000), many of whom are highly dependent on marine resources such as fish, but also have a significant impact on resource status. However, as national poverty alleviation strategies have tended to neglect the importance of natural resources in peoples' livelihoods, a majority of people in coastal communities are categorised as living at or below the national poverty line.

Over-fishing and destructive fishing techniques that cause habitat destruction, coupled with a rising population are of particular concern in Tanzania (McClanahan et al 1999, Obura 2005, Wells et al. 2007a,b). Dynamite fishing remains a contentious issue in Tanga region, even after concerted efforts to control it were put in place (Samoilys et al. 2007). Such unsustainable practices are partly embedded in poverty, and continue because poverty reduction strategies are failing in coastal communities. However, there are several other contributing factors, including collusion and support from parts of both the private and public sectors. In addition, coastal communities remain disempowered in terms of ownership of marine common pool resources. Reduction of poverty through sustainable livelihood development, which in turn helps turn people from destructive practices, maintain biodiversity and improve conservation strategies (Ireland et al 2004, Harrison 2005), is a pressing theme that requires careful analysis, community consultation, and integration of cross-sectoral planning and management.

This study seeks to map coastal peoples' perceptions of marine resource use and their dependence on marine resources, changes in resource status, and what effect conservation and resource management have had on coastal peoples' socio-economic development, in order to understand the bottlenecks to good governance of common pool marine resources. Tanga Region in northern Tanzania and the Kiunga area in northern Kenya were selected for case study analysis due to considerable conservation and management intervention in these areas over time. The findings of the Tanga case study are presented herein. Findings from the Kiunga case study are published separately in a report by the same authors (Samoilys and Kanyange 2008).

1.1 Study location

Tanga Region is situated in northern Tanzania, bordering Kenya, and covers the coastal districts of Mkinga, Tanga City, and Pangani (prior to changes in 2005 and 2006 the districts were known as Muheza, Tanga Municipality and Pangani, the term "Tanga" is used herein to refer to the entire coastal area of the region, unless otherwise stated). The region is hot and humid, with fairly fertile soils and significant stands of coastal tropical forest. The area covers 1,600km², encompassing numerous islands surrounded by coral reefs, extensive seagrass beds, mangroves and also deep channels and drops offs (e.g. Horril et al. 2000, see Figure 1). Tanga is host to numerous migratory birds, the endangered coelacanth (*Latimeria chalumnae*), which was long thought to be extinct, and may still support a small population of dugongs. WWF has identified Tanga as an eco-regionally important seascape within WWF's East African Marine Ecoregion (EAME).

The 2005 population estimate for the region was over half a million people, with half living in Tanga City (Wells et. al. 2007a). The main coastal livelihood is fishing, though farming is also done on a small scale. Other livelihood activities revolve around trade in fish and molluscs, mangrove cutting and selling, boat



Figure 1. Map over the coastal area of Tanga Region, including Collaborative Management Areas established under TCZCDP (from Wells et al. 2007).

building, salt boiling, and charcoal making (Horrill et al. 2001, Ireland et al. 2004). Overall there is a high reliance on marine and coastal natural resources, exerting more pressure as the population grows and demand for food increases.

1.2 Marine resource management and coastal community development

Tanga is renowned for its Tanga Coastal Zone Conservation and Development Programme (TCZCDP), which was initiated in 1995 to address coastal zone and fisheries management in the Region. This long-term programme, implemented by the International Union for the Conservation of Nature (IUCN) in partnership with the Tanga Regional and District governments, operated with donor funding until 2007. It continues today as the Tanga Coastal Zone Resources Center, a District and Regional government programme. Despite this significant initiative, fishery stocks are again in decline, the highly destructive use of dynamite fishing has escalated since 2005, and poverty among coastal communities in the area remains an issue of high concern (Samoilys et al. 2007a, Wells et al. 2007).

Efforts have also been made to develop mariculture as an alternative livelihood for local communities in the coastal areas of Tanga. In the late 1990s TCZCDP, in collaboration with stakeholders and partners, encouraged and supported fishermen and women to venture into mariculture (Lugazo et al. 2007). This was then taken up actively in 2003 by the USAID funded project Smallholder Empowerment and Economic Growth through Agribusiness and Association Development (SEEGAD), largely focusing on seaweed farming. In 2005 SEEGAD evolved into the still active Sustainable Environmental Management through Mariculture Activities (SEMMA) project. These processes are discussed in more detail in section 3 below.

1.3 Study objectives

This study set out to examine resource management, use and development issues in Tanga, in order to understand constraints to sustainable development. The study asked local communities for their perceptions on these issues to provide a first hand community view on the importance of marine resources in their lives, what they perceive the problems are, and how they would like to engage in addressing them.

Existing information on the link between coastal peoples' livelihoods and marine resource management was compiled, with a particular focus on dynamite fishing and sustainable fisheries, as well as past work on livelihoods enhancement, especially aquaculture and associated capacity building, empowerment and participatory approaches. In addressing these objectives the study provides a review of the main fisheries development initiatives and interventions in Tanga, as well as their contribution to capacity building and poverty eradication.

2. Methods

The study was conducted in January 2008 and employed four methods: i) a literature review of recent publications and reports; ii) informal interviews with managers and government officials; iii) informal interviews with key informants as well as participants in the national coastal community lessons learning workshop held during the period of the study; and (iv) field visits to observe activities in situ that had been mentioned during interviews. These included field visits to two groups practicing mariculture south of Tanga City and one lobster aggregation fisher group in Pangani District. Information was synthesised in relation to findings and recommendations from the national coastal community lessons learning workshop held in Tanga in January 2008 (Becha 2008), organized by IUCN.

Interviews and consultations were structured to answer the following questions regarding the two specific focal issues, dynamite fishing and mariculture:

Mariculture

- 1) What various mariculture activities are there in the region? Where?
- 2) Who is involved and why?
- 3) What are the economic gains? Is the practice economically sustainable?
- 4) What are the problems facing each practice (incl. e.g. milkfish, crab, oyster, seaweed)?
- 5) Has the government or other stakeholders played a part in development of the sector?
- 6) What is the future for the sector?

Dynamite fishing

- 1) Where and when did the practice start? Who started it and how?
- 2) What are the initial costs and gains?
- 3) What are the community perceptions about the practice? How harmful is it?
- 4) Are there any conflicts with other stakeholders, including fishers?
- 5) Why has it continued despite its ban?
- 6) What can be done to stop the practice?
- 7) What local action has been taken and how effective has it been?
- 8) Where or how do fishers acquire dynamite?
- 9) Why has gear exchange not worked for dynamite fishers?
- 10) Why is dynamite fishing a problem in Tanzania but not Kenya or Mozambique?

3. Results and Discussion

In this section we present and discuss the results of the study. First we provide an overview of past and current coastal zone and natural resource management initiatives in Tanga Region, second we analyse dynamite fishing, one of the most critical threats facing Tanga's marine environment, and third we present information on alternative livelihood programmes focussing on mariculture. In discussing our findings we consider the impacts of various marine and coastal management issues on the socio-economic status of the people of Tanga Region.

3.1 Coastal zone management and fisheries development programmes

TCZCDP has been a central force in coastal zone management in Tanga Region, addressing mainly fisheries management, and to some extent fisheries development. The Programme was implemented through District governments with advice from the Region. Since the lead technical agency, IUCN, handed over the programme to government in 2005 and funding from the donor, Irish Aid, ceased in 2007, the programme has been integrated within District government workplans and budgets as the Tanga Coastal Zone Resources Center, though with a significantly reduced budget and range of activities. Nevertheless, e.g. the status of the reefs and fisheries continue to be assessed by District officers in collaboration with Village Monitoring Teams (Samoilys 2004). The Fisheries Division, though poorly equipped technically and financially, has continued to support fisheries development in the region while the Forest Department facilitates some programmes at the village level, especially those initiated by village environmental committees (Wells et al. 2007a).

Other significant interventions include the SEEAAD project, with the overall objective to promote activities that drive sustainable economic growth, and to increase cash incomes and stimulate asset accumulation among coastal households in Tanga (ACDI/VOCA 2008a). Activities were successfully concentrated on promoting seaweed farming, with improved incomes for a high number of farmers, especially women (ACDI/VOCA 2007a). Mariculture ventures using mud crab, prawn and lobster were also introduced when market assessments revealed they had potential. SEEAAD evolved into a new programme, SEMMA, with the aim of conserving biodiversity along the Tanzanian coastline through sustainable development of profitable mariculture enterprises (ACDI/VOCA 2008b). SEMMA has focused mainly on crab fattening due to its high

potential for economic return; recent crab fattening trials have been successful and more are underway (ACDI/VOCA 2007b). These initiatives are discussed in more detail in section 3.3 below.

3.1.1 Tanga Coastal Zone Conservation and Development Programme

TCZCDP was initiated in 1994 in response to the Tanga Regional government's concern for an increasing decline in marine resources and reef degradation, and was implemented through IUCN's Eastern Africa Regional Office (EARO) with funding from Irish Aid. TCZCDP was one of the first coastal management programmes in the Western Indian Ocean to make livelihoods improvement a central objective, and one of the first to take a community-based approach to planning as well as implementation from the start. A very broad and ambitious strategy was taken, incorporating attempts to trial and implement new livelihood activities, develop and implement fisheries and mangrove management plans, establish and mainstream new institutional arrangements for coastal management, and build capacity through a major training and environmental education programme (Wells et al. 2007a). The Programme covered over 1,600 km² and encompassed over 200,000 relatively poor people in 49 communities. The Programme was implemented collaboratively by local government offices of the Districts of Tanga Region (Tanga municipality, Muheza and Pangani, later named Tanga City, Mkinga, and Pangani).

Developing collaborative management arrangements, and changing behaviours and attitudes, is a slow process. The long-term commitment of funds from Irish Aid over four phases and a total of 12 years enabled TCZCDP to operate through an adaptive management process, with time to monitor and analyse the programme and change approaches where needed. This was unusual for the East African region and was one of the Programme's great strengths.

Fisheries management interventions included the establishment of collaborative management areas (CMAs), which were formally gazetted through village by-laws and approved at national level (Wells et al. 2007c, see below). These included reefs closed to fishing to serve as fishery reserves. Destructive and illegal beach seines (*juya*) and dynamite fishing were dramatically reduced through surveillance patrols and gear exchange for beach seines (Horrill et al. 2001). Regular monitoring of coral reef health and artisanal fisheries, as well as implementation of alternative livelihood strategies such as seaweed farming by women were further key aspects of the programme. Generally, TCZCDP led to a significant improvement in reef health, at least until 2003-2005, when both dynamite fishing returned and a reverse in the recovery of fish stocks was seen (Samoilys et al. 2007a,b).

3.1.1.1 Collaborative Management Areas

The main achievement of TCZCDP has been the development of a collaborative approach to preparing coastal and marine resource management plans, the so called Collaborative Management Area Plans (CMAPs) that are broadly satisfactory to both communities and the government, with implementation shared by villages, District administrations and regional/national authorities. There is little doubt that fishers and coastal communities in Tanga Region now have a much greater involvement in, and understanding of, natural resource management and a concomitant greater sense of ownership (Wells et al 2007d).

CMAs are based on resource use, specifically on shared fishing grounds, and therefore involve several villages in each CMA (see Figure 1). This has helped reduce conflicts and address the difficulties of managing common pool resources. The CMA approach differs from the Beach Management Unit (BMU) approach introduced by the Fisheries Division to improve community based fisheries management. BMUs consist of a group of people associated with a landing site, a concept borrowed from the Lake Victoria fisheries. We believe the geographic scale of a landing site is too small for managing coastal marine fisheries and is likely to lead to conflict. Regrettably the CMA approach of the TCZCDP was not well considered at the national level when the Fisheries Act was revised in 2003 and the BMU concept introduced.

Some difficulties were also encountered in the TCZCDP CMA approach. For example, incentives were important to encourage participation, there was lack of cooperation from some members of the community,

and laxity among some authorities. However, overall it can be seen as a success and a valuable model. A major setback in terms of impact is the failure to completely eradicate dynamite fishing in the region (see below).

3.1.1.2 Capacity building within TCZCDP

Capacity building by TCZCDP in collaboration with partner institutions was a key focus of the programme though its effectiveness is hard to measure (Mzava et al. 2007). The programme included organizing extra curricular environmental education in schools as well as youth clubs, and conducting adult training in enforcement, business entrepreneurship, environmental awareness, project management and gender issues, among others. Several thousand children and youths benefited from the environmental education programmes, several hundred villagers and local government staff received training and skills development, and women were considerably empowered (Mzava et al. 2007). Activities relating to awareness raising and infrastructure development further contributed to capacity development for coastal management. Individuals in both villages and local government report that they regularly use the skills and techniques gained from the training provided by the TCZCDP, not only in coastal management activities but also in other aspects of their lives.

Stakeholder representation in the programme improved through its four phases. The forum for stakeholders and the regional workshops conducted at the onset of the programme finally culminated in the Tanga Coastal Consultative Forum (TCCF), a regional body that meets twice a year to discuss coastal management issues. TCCF illustrates the broadly integrated and participatory nature of the programme, with representatives from the national office of the Ministry of Natural Resources, the Ministry of Environment in the Vice President's Office, Tanzania Coastal Management Partnership (TCMP), and SEEAAD. The Programme also forged partnerships with scientific institutions such as the Coastal Oceans

Photo: Mangrove crab farmer (© M Samoily).



Research and Development in the Indian Ocean (CORDIO) project, and the Institute of Marine Sciences (IMS) of the University of Dar es Salaam.

3.1.1.3 Benefits to coastal communities from TCZCDP

TCZCDP was initiated at a time when the economic outlook of Tanzania was rather bleak, but was implemented over a period of considerable economic change in Tanga Region and the country as a whole (Wells et al. 2007d), which had some bearing on the evolution of the programme. A significant change in TCZCDP that occurred in response to recommendations from external evaluation was to stop revenue-generating activities in 1998, and to focus on marine resource management only, a decision that was unpopular in the communities. Interestingly, one of the final evaluations recommended that the programme should re-engage with such activities because the problems of coastal and marine resource management will not be solved unless poverty and livelihoods are directly addressed. Although the adjustment of the programme to focus more on fisheries related activities was justifiable in view of available resources, the subsequent difficulties encountered demonstrate that improving the livelihoods of poor coastal communities ultimately requires that attention is paid to all livelihood strategies in use, a point increasingly being made in discussions on sustainable development (Allison and Ellis 2001, Ireland et al. 2004, Ruitenbeek et al. 2004, Wells et al 2007d).

Assessing whether natural resource management interventions in Tanga have resulted in improvements to livelihoods is difficult, particularly because socio-economic monitoring was not carried out until 2004. Empirical evidence of links between management of marine resources and trends in household income are not available. Many people in Tanga Region, both in the government and in the villagers, perceive that there has been an improvement in the social and economic well being of coastal communities over the last decade (Wells et al. 2007d). For example, one community and some government officials said that more children were going to school and had shoes, and these individuals considered the programme at least partly responsible. Fishers have stated in TCZCDP evaluations that their livelihoods have improved, possibly because they now have a much greater control over the resources they use (Wells et al. 2007d). But there could be many causes, as many other changes since TCZCDP was initiated that affect people's livelihoods have been seen, e.g. a general improvement in the Tanzanian economy (Al-Samarrai and Reilly, 2005) and a number of other donor-funded development projects in the three Districts aimed at livelihood improvement for rural populations (Anon, 2005).

There is often an assumption, or intention, that improving the income of coastal communities through alternative livelihoods development results in an improvement in the status of natural resources (e.g. a reduction in fishing, or in the use of destructive fishing methods), or that alternative livelihoods will compensate for income lost if open access for fishers is restricted (e.g. through no-take areas). Such effects often fail to materialise (Vincent, 2006). However TCZCDP did show that fishers (in this case beach seiners) were willing to move into agriculture and thus potentially reduce pressures on marine resources (Wells et al. 2007d).

One of the more interesting observations from the TCZCDP was a simple economic argument made by Lewis and Juma (2005) when carrying out the final evaluation of the Programme. They estimated that 1 km² of inshore water in Tanga Region has cost about USD 500 per year to manage over the last 12 years, based on the average annual budget of TCZCDP and the total area covered by the CMAs. TCZCDP staff estimate that about USD 130/km² would now be sufficient. Since fish yields of USD 2,500/km²/yr are reported from Tanga (Anderson 2004) the value of investing only USD 130/km²/yr is clear (it should, however, be noted the sustainability of this yield was not determined). Such economic calculations are, although simplified, not widely understood or accepted by the stakeholders. Fishers as the primary beneficiaries of these valuable fishery yields need to hear and understand these arguments, as do government and those making budgetary decisions nationally. Other examples that illustrate this point can be seen from neighbouring Kenya where the value of the reefs and associated ecosystems of Kisite Marine Park and Mpunguti Marine Reserve (c. 40 km²) just across the border from Tanga region has been estimated at about US\$2 million a year (Emerton and Tessema, 2001). Studies from other parts of the world indicate values from just under

USD 1,000 to several thousand USD per km² of reef a year (UNEP-WCMC 2006), depending on the location, uses etc.

3.1.2 IUCN Community Consultation Workshop

Another activity implemented by IUCN linked to the present study was a national workshop hosted by CORDIO and East African Wildlife Society (EAWLS) in Tanga in January 2008 (Becha 2008). The workshop was designed for coastal communities to share lessons in marine resource management to build their capacity and to generate bottom-up policy advice in order to strengthen policies for the sustainable management of Tanzanian marine resources. Key recommendations were developed by dividing participants into four groups, based on common resource management and resource use objectives, activities and interest: mangrove rehabilitation and seaweed farming; marine natural resource and conservation area management; small-scale fishers; and small-scale traders (commerce and socio-economic development). The recommendations made by three of these groups have also informed the present case study, and are listed below.

Seaweed farming group

- The government should formulate policy guidelines on seaweed farming and trade to safeguard the farmers from unscrupulous investors and traders. The market should be open to increase competition between buyers. It should not be controlled by District Fisheries Officers.
- Seaweed farming guidelines must have provisions to protect the investment in the seaweed farms from illegal and destructive fishing practices such as the use of poison and nets with small mesh size.
- The government must recognise seaweed farming as an alternative income-generating activity of value to be incorporated into national economic development planning. For example, it should be mentioned specifically in the national policies and programmes for poverty eradication and achievement of the Millennium Development Goals.
- Communities need training in business and investment to increase their production (through more seaweed lines and tools) and to be freed of control by the buyers.

Marine conservation and management areas and conservation committees group

- Conservation area committees must be well equipped and trained to maximise their enforcement and management capacity. The government should support these committees through specific programmes.
- The government should review marine legislation and increase the severity of penalties for offenders. To this end, the courts and responsible departments must be strengthened and should work closely with local conservation committees.
- The government should ensure communities have better access to information and regulations concerning natural resources such as forests, minerals, fisheries and the environment.
- Fisheries regulations should be properly enforced. Offenders must be prosecuted. Dynamite fishers should be severely punished.

Small-scale fishers group (*wavuvi wadogo wadogo*)

- Communities must acknowledge the problems and assume responsibility for solving them.
- The government must translate the Fisheries Act and regulations into Kiswahili so that the information is accessible to fishers.
- The government should speed up the establishment of BMUs as stipulated in the Fisheries Act 2003. BMUs have the potential to act as strong pressure groups against illegal fishing. They should be involved in boat licensing and enforcement patrols (as done by the Lake Victoria BMUs).
- Training programmes should be initiated to build up the management resource pool for coastal and marine resources.
- The Ministry of Natural Resources and Tourism should expand and sustain awareness and education programmes for fishers on topical issues such as sustainable fisheries practices, including the use of appropriate fishing nets and gear.
- Local fishers and local natural resource management committees should be included in the monitoring teams that control foreign fishing vessels.

- To overcome corruption amongst fisheries officers, there should be close supervision and monitoring of the work and performance of the fisheries officers by their supervisors. Local people should participate in monitoring and evaluation.
- Fishers must be helped with alternative income-generating activities and be given easy access to loans.

3.2 Dynamite Fishing

Dynamite fishing is the practice of using explosives to kill or stun fish for collection. Often, home made explosives made from a mix of artificial fertiliser and kerosene are used. Due to the damage it causes to aquatic biota and environment, and the risks involved for the users, the practice is outlawed in almost all countries in the world. In spite of this, dynamite fishing is still rampant in Southeast Asia and parts of Africa. In Southeast Asia, the Philippines bears the unfortunate reputation for extensive dynamite fishing, dating back to the second World War, with American troops making dynamite easily available and reputedly using the methods themselves. In Africa, Tanzania is known for dynamite fishing which has been practiced since the 1960s (Talbot 1960, Ray 1968, Bryceson 1978, Guard and Masaiganah 1997), despite being prohibited under the 1970 Fisheries Act (and later also the 2003 Fisheries Act). By the 1980s and 1990s the practice was rampant, with some Tanzanian fishers even venturing into neighbouring Kenya to dynamite reefs in Kisite Marine National Park (Samoilys 1988).

3.2.1 Impacts of dynamite fishing

Environmental, economic and social impacts of dynamite fishing around coral reefs have been well documented. Dynamite fishing destroys corals leading to significant loss of a reef's biodiversity. Damaging both the living coral tissue and the underlying basal framework of the reef, dynamite fishing is able to also destroy more massive coral forms such as *Porites* spp. and *Pavona* spp. (Samoilys 1988, Solandt and Beger 2000). Continued blasting can completely destroy a healthy reef. The resulting loose rubble is unsuitable for most organisms to settle on, including coral planulae (larvae), due to the regular movement of the rubble by wave action, and it is only when the rubble becomes consolidated, e.g. by growth of coralline algae cementing pieces together, that coral can re-settle and grow. Sea urchins, particularly *Diadema* spp., appear to favour damaged reefs and are seen in high abundance on some of the more impacted sites in

Photo: Healthy reef (© TCZCDP) and reef damaged by dynamite fishing (© J Tamelander/IUCN).



Tanga (Samoilys et al 2007b). In addition, brown macro-algae (e.g. *Sargassum*, *Turbinaria* spp.) often invade damaged reefs and then out-compete young corals. This can result in an ecological phase shift, where coral reefs never recover as coral reefs but become macro-algae dominated reefs (McCook 1999, Samoilys et al 2007b), with greatly reduced fisheries productivity and biodiversity.

The size of the coral area destroyed by a single blast depends on the size of the bomb and position of the explosion relative to the coral reef (Samoilys and Carlos 1992, Pet-Soede et al. 2000). A blast on the coral reef completely reduces it to rubble within a few to several metres of the blast site, killing all fish and most other organisms within a 15-20m radius (Guard and Masaiganah 1997). In some areas of the Indo-Pacific, blast fishing is responsible for 50 percent habitat destruction (CCIF 2001, Woodman et al. 2004). On the Tanga coast, an IUCN survey in 1987 found that reefs were extensively damaged, with an average of < 20% live coral cover on most reefs, some with <10% and as little as 1% on one reef (Bensted-Smith 1988). A wider survey in 1995 found that of the 58 coastal and patch reefs studied, 12% were completely destroyed, 64% were in a poor or moderate condition and the remaining 24% were in a good condition (Horrill 1996). The worst damage corresponded to reefs adjacent to the highest human population densities, and most of the damage was attributed to dynamite fishing (Horrill 1997).

Loss of aesthetic value of the reef, risk of physical harm including death to dynamiters and unsuspecting tourists and marine mammals following spontaneous explosions, loss of livelihood by fishers due to habitat destruction and social ostracising of the offenders have all been documented as immediate consequences of dynamite fishing. Short-term economic gains are high but diminish in the long term if dynamite fishing is carried out in the same area. In Tanzania, a timely single blast can stun and kill fish worth over USD 100 and even up to USD 1,000, using a blast worth only USD 30 (Riedmiller 2006). Unfortunately, dynamite fishing operations are still profitable enough to ensure a high degree of organization, including the collusion of individuals within local authorities (CCIF 2001).

In the longer term the negative impact on the fishery resource as well as the services the ecosystem can provide is significant. Dynamite fishing is already posing a serious threat to the recently developing coastal tourism sector in Tanzania, a concern raised by several people interviewed.

3.2.2 History of dynamite fishing in Tanzania

Dynamite fishing in Tanzania dates back about 50 years, characterised by phases of appearance and disappearance in some parts of the country. In the 1960s, two people, one a scientist and the other a fisher, used dynamite for research and fishing respectively in Tanzania. Since then the practice spread to other parts of the country. A 50-year-old resident from Tanga confessed that he grew up while dynamite fishing was going on but was unable to tell exactly when it started.

3.2.3 Dynamite fishing along the Tanga coast

The use of dynamite to catch coral reef fishes in Tanga region (NB some also target pelagic fish) appears to be an organised practice: the boat and the dynamite are provided by a “business man” who employs the fishers as crew on his boat, and also facilitates sale of the fish. Although dominated by men, some women are engaged in trading dynamited fish, and may invest in the practice. Companies in the mining and construction material industries, as well as the armed forces, have been identified as sources of dynamite by local communities.

When TCZCDP was initiated in 1994 a strong monitoring, surveillance and control programme was set up to address this highly destructive practice as well as control other illegal fishing practices. Shortly thereafter the Navy was brought in to be part of TCZCDP’s patrol units. This effort resulted in reducing blast incidences from over 180 a day in 1995 to zero in the following year, with very low incidence persisting thereon for around eight years (Verheij et al 2004). Awareness of the long-term negative effects of dynamite fishing among communities reportedly resulted in more requests for enforcement against the few persistent dynamite fishers. This eventually led to the perception that TCZCDP had brought this practice to a near halt by 2000 (Verheij et al. 2004). However, with the withdrawal of the Navy in 2004, and winding down of the

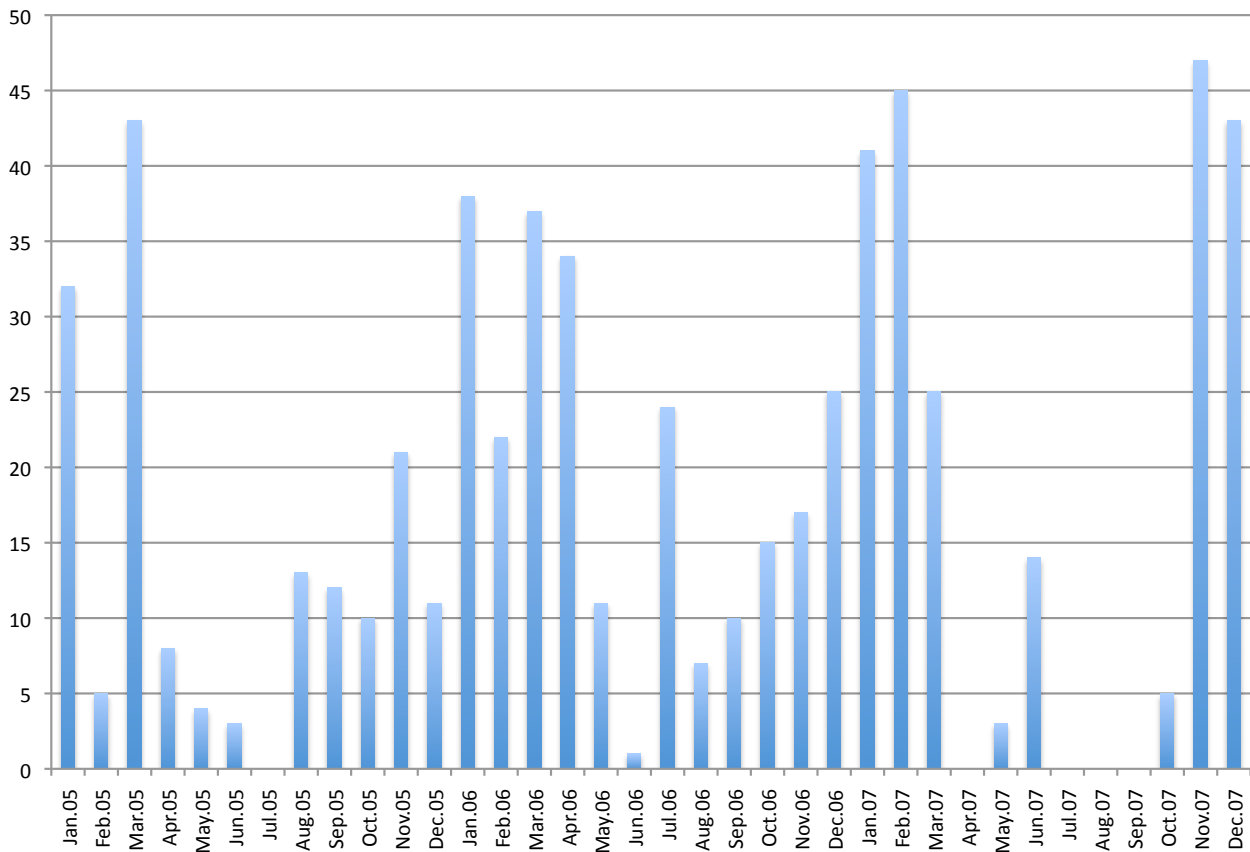


Figure 2. Number of reported dynamite blasts from 2005 to 2007, at and around Kigombe and Mwambani, Tanga Region, based on data from Tanzania Dynamite Fishing Monitoring Network. The use of dynamite in areas out of earshot is likely to cause some under reporting.

donor-funded TCZCDP in 2005, dynamite fishing resurfaced (Samoilys et. al 2007a). A high incidence of dynamite fishing, in the order of 30-50 blasts per month in certain areas, was reported by local civil society networks (see below, Fig 2). This increase was noted in particular on reefs off the villages of Kigombe, Sahare, Tongoni and Chongoleani (note that this does not entail proof of the village of origin of dynamite fishers). A villager from Kigombe reported hearing 10 blasts a day in January 2008 and also insisted that dynamiters are now not even deterred by the personal physical consequences that include loss of limbs, blindness, deafness and even death.

The impacts are increasingly obvious. For example, gill net fishers in Tanga Region now say they are forced to venture further offshore to fish in deeper waters because their traditional shallower areas are unproductive, in large part due to dynamite fishing. It is these fishers that incidentally have been capturing large numbers of coelacanths in deep-set nets on outer slopes.

A number of reasons were reported by villagers as causes of the renewal of dynamite fishing in Tanga, though responses varied considerably. Resurgence could be associated with easier acquisition of dynamite from construction of the bridges on the Tanga-Mombasa road, and the withdrawal of the Navy also apparently greatly reduced the effectiveness of the local patrol units. Other reasons given were: an ineffective judicial system failing to prosecute and convict offenders, incapacity or at times collusion among authorities responsible for policing such illegal activities, increasing poverty, and ineffective and inadequate patrol and monitoring by the government. Given the overall development of the area, the magnitude of dynamite fishing and the comparatively low number of people directly engaged in it, it would appear that poverty is not a root cause but a facilitator, although villagers cite it as a major cause.

3.2.4 Legal context of dynamite fishing in Tanzania

A dynamite fisherman taken to court is potentially faced with four counts of crime: illegal possession of dynamite, fishing without a license, using an illegal gear and fishing with dynamite, all of which can result in severe punishment, including five to ten years imprisonment for fishing with dynamite as per the Fisheries Act 2003. However, few are prosecuted, and even fewer go to jail. A village representative from the heavily fished Kigombe area confessed not to have known anyone jailed for even six months. Instead fines of as little as TZS 40,000 (c. USD 33) are issued at times, while 'severe' fines ranging between TZS 100,000 to 200,000 (c. USD 80 to USD 160), are rarely imposed. Interviewees stated that these fines are usually paid by the "businessman" backstopping the dynamite fishing operation.

Interviewees in Tanga unanimously stated that judicial procedures are ineffective and inefficient. Many of those interviewed also said that they felt this was deliberate. Sentences and fines were seen as too lenient while cases take a very long time to conclude. Judicial processes are lengthened e.g. since fish brought to court as evidence needs to be verified and approved by a laboratory, which takes time. Sometimes no action is taken even when communities notify authorities that dynamite fishing is occurring and patrols boats are close by, and in cases where villagers apprehend the culprits themselves courts are reluctant to investigate cases, and villagers live in fear of reprisals against informants.

Individuals and local group initiatives fighting against blast fishing stated that they are often frustrated by what they see as inaction on the government's side. Scheinman and Mabrook (1995) cite the major impediments to eradicating this vice as an inadequate judicial system, with government officers in Tanga rendered ineffective through intimidation or bribery. They further went on to equate those organising dynamite fishing as criminals similar to urban drug dealers, an analogy used by Tanga residents today.

3.2.5 Current initiatives towards control and elimination of dynamite fishing

In recognition of the renewed intensity of dynamite fishing in Tanga since 2005, various initiatives have been set up, either by individual groups or by the government, but despite these and recent international attention to the problem, control on the ground remains elusive.

3.2.5.1 Government Patrols

In recognition of the seriousness of the dynamite fishing problem in Tanga the government set up a specific patrol unit for Tanga in 2006. Villagers from heavily dynamite fished areas around Mwarongo and Kigombe villages said that patrols were inadequate and ineffective. They stated that the unit is not armed and depends on the Police Department in order to operate, including apprehending and prosecuting suspects. An officer at Tanga Coastal Zone Resources Centre conceded that the patrol unit is not in a position to patrol or respond to hotline calls due to inadequate staff and resources such as boat fuel.

Further factors that contribute to the difficulties in curbing dynamite fishing in Tanga region were put forward during interviews. For example, usually one days notice is required before a patrol takes place, but information is quickly leaked, giving illegal fishers enough time to organise themselves and avoid capture. Several among the local communities consulted for this report believe this to be due to collusion between the dynamite fishers and their financial backers and investors, and individuals in the administration and/or police. It was further reported that a trust fund for the investors in dynamite fishing has been created, into which members contribute money that can be used to pay for the fines imposed on individual fishers. Fishers also suggest there is political patronage of dynamite fishing. On the other hand, incidences of intimidation of fisheries officers are also known to occur. The issue of readily available dynamite was also raised by several people interviewed. Procedures such as tagging dynamite for unique identification have been proposed by some government officers as one possible control measure. However, the increasingly used home-made fertilizer bombs would escape such controls.

3.2.5.2 Community vigilance

Dynamite fishers were reported by village representatives to have migrated southwards from Tanga town, partly explaining why the southern reefs of Mwarongo and Kigombe are experiencing heavy blasting, compared with the already heavily dynamited and damaged northern reefs where blast levels these days are lower. At the community level, villagers are setting up patrol committees and also trying to persuade dynamite fishers to abandon the practice. In some villages, dynamite fishers have been banished and are said to have sought refuge in the neighbourhood where they continue with the practice. Overall these efforts are said not to be succeeding, and villagers stated they needed more support from the government. According to a representative from Kigombe, fines were higher and surveillance was more intense before the Naval unit based in Tanga was redeployed in 2004. From the villagers perspective, catches have declined tremendously in the last years, a trend also reported from scientific monitoring (Anderson 2005, Samoilys et al 2007a, Wells et al 2007b). Community representatives also stated that the use of environmentally friendly gears such as fence traps (*uzio*) has stopped completely. Fishing has now become economically unsustainable in some villages, with fishers earning on average TZS 1,760 (c. USD 1.3) in a day.

3.2.5.3 Tanzania Dynamite Fishing Monitoring Network

Tanzania Dynamite Fishing Monitoring Network (TDFMN) was set up in 2005 by a group of people from conservation organisations, the private sector, government, donors, and local marine resource users, including representatives of Village Environmental Committees and the commercial fisheries and tourism industry. The network was established to assist government in halting the dynamite fishing by exposing and monitoring its occurrence in Tanga Region.

TDFMN collects dynamite fishing information through personal observations over a relatively small area where network members live and/or work. Information collected includes date, time, location, and number of blasts, as well as details such as vessel registration number, which is then passed on to government authorities in Tanga. Detailed data are also circulated in a newsletter through emails to a broad list of recipients, both in Tanzania and abroad, to promote dialogue and discussion. The data shows high incidences of dynamite fishing presently, with an increase since 2006 (Fig. 2). Due to the small coverage of the network this is likely to under-represent the true levels of dynamite fishing in Tanga Region. The TDFMN has also generated a 'blacklist' of offenders, i.e. people believed with little doubt to be either directly involved in or in some way supporting or facilitating dynamite fishing, actively or by neglect of duties. The list has been handed over to the Tanga patrol unit and other authorities.

TDFMN has not, however, operated without criticism. The network was strongly criticised by the Zanzibar government at a meeting in 2006 (Yussuf, 2006), although recently the government has acted on the TDFMN blacklist (see 3.2.5.5 below).

3.2.5.4 Friends of Maziwe Island and Friends of Coral Reefs in Tanga

Maziwe Island National Reserve is gazetted as a no-take zone under the Marine Parks and Reserves Act. Tourists visiting the reserve are charged TZS 3,000 (c. USD 2.4), which supports local patrols as well as community welfare. Patrols conducted jointly by committees comprised of villagers from Ushongo and Pangani, council personnel and private investors, mainly hoteliers, have worked well. The Reserve has been well protected from all types of fishing including dynamite fishing, with only one exception. In 2006 the local patrolling reportedly ceased and taken over by the TCZCDP patrol, but poaching and blasting occurred to the extent that tourists refused to pay the entrance fee. Eventually the former local patrolling resumed.

Friends of Tanga Coral Reefs is an association largely supported by local tourist hotels, and is linked to the wider TDFMN in efforts to combat dynamite fishing.

3.2.5.5 Recent government and donor action

A high level meeting on dynamite fishing was organised by the Government of Tanzania in December 2007, with support from the British High Commission, WWF, Fisheries Division and IUCN. The meeting was attended by two Ministers, two Deputy Ministers, the British High Commissioner, the Chief of Staff at the Ministry of Defence, the Commander of the Navy, seven Regional Commissioners, seven Regional Police Commanders and other senior officials from the Police, Navy, Attorney General's Office and Fisheries Division.

The high level meeting generated significant press coverage at the time, and the government stated that it would have “zero tolerance” for offenders. The Tanga patrol unit was said to now have more “teeth” and there was a short decline in incidences of dynamite blasts. However, this has not been sustained, and already early in 2008 high incidence of dynamite fishing was again reported by TDFMN. However, recently (June 2008) the provisional blacklists prepared by TDFMN and the NGO Sea Sense (operating in Temeke District south of Dar es salaam) were used to inform a national enforcement operation by the Police, Navy and the Fisheries Division. A land-based night operation, funded by WWF, was conducted, during which approximately 120 Police, Navy and fisheries officers sought to apprehend as many as possible of the 100-150 blacklisted individuals. The operation caught c. 30 fishers, and is said to have convinced some dynamite fishers to stop the practice. It is seen as a first step in a revitalized process of curbing dynamite fishing (J. Rubens pers. comm.).

3.3 Mariculture along the Tanga coast

Many programmes have focused on mariculture as a way of diversifying livelihoods and reducing pressure on marine resources. TCZCDP demonstrated considerable potential for mariculture in Tanga Region, and contributed to awareness among communities and the Districts of the potential for mariculture activities. Different aspects of mariculture were introduced to an estimated 1,575 people, including 220 women. Over 20 individuals received training to the level that they could pass on their experience by training others. In addition, TCZCDP developed a preliminary knowledge base as a result of the trials with tilapia and oyster culture (Wells et al. 2007d, Zuberi et al. 2007).

Photo: Mangrove crab fattening cages (© M Samoilys).



One of the more notable mariculture activities in Tanga is seaweed farming. This involves farming two species of algae introduced into Tanzania from the Philippines, *Eucheuma spinosum* (also known as *denticulatum*), introduced in 1989, and *Kappaphycus alvarezii* (previously called *cottonii*), introduced around 1996 (Zuberi et al 2007). Production has increased dramatically in Tanga over the last 10-15 years, due in large measure to the overall growth in the industry nationally and promotion by the private sector. By 2003 seaweed farming was directly benefiting 305 people in Tanga Region, the majority women (Zuberi et al. 2007). Tanzania is a leading minor producer of this type of seaweed, after the Philippines, China, Malaysia and Indonesia, according to the Food and Agriculture Organization of the United Nations (FAO).

Seaweed farming, however, probably does not take much pressure off marine resources as it is carried out predominantly by women, while fishery resources are exploited mainly by men. It may reduce impact of other activities traditionally undertaken by women, though, such as reef gleaning and collection of firewood. In general, fishermen in Tanga region were found to not be interested in seaweed farming because income from it was lower than that generated from fishing, and it involves hard labour. However, if prices improve, more men may become involved and reduce their fishing activities (Wells et al. 2007d).

TCZCDP also carried out trials on milkfish, prawn, tilapia, and oyster culture, as well as the use of fish aggregating devices (FADs). These were unsuccessful, while introduction of habitat structures for lobster attraction worked well. The reasons for the limited success included lack of seed, markets and technical expertise. However, the trials were short-lived, and the main reason TCZCDP did not continue with these and other alternative income generating activities was the recommendations to stop these activities in 1998 in an external review of the programme. The Division of Fisheries provides limited support to mariculture development largely due to a lack of technical knowledge and experience.

In 2003 the US-based NGO Agricultural Cooperative Development International and Volunteers in Overseas Cooperative Assistance (ACDI/VOCA), established the SEEGAD project, to be called SEMMA form 2005, with funding from USAID. The project has played a pivotal role in mariculture training in Tanga (Savoie 2005, ACDI/VOCA 2007,a,b), focusing mainly on seaweed farming and also conducting successful mangrove crab (*Scylla serrata*) fattening trials (ACDI/VOCA 2008b). SEMMA suspended its support for culturing penaeid prawns (shrimp) and milkfish (*Chanos chanos*) due to e.g. low or unreliable seed availability, as well as technical and market constraints, although some community groups are still practising milkfish farming. SEMMA's main conclusion regarding culture of these animals is that hatcheries are essential if mariculture is to be sustainably conducted and scaled up. Currently there is no hatchery in East Africa though there are plans to construct one for prawns in Bagamoyo. SEMMA are applying for funds for a mangrove crab hatchery in Tanga.

3.3.1 Value chain analysis

Before further promoting and developing mariculture along the Tanga coast and in Tanzania in general, conducting value chain analyses, preferably involving private investors, to identify constraints and opportunities for various mariculture schemes is essential, as strongly advocated e.g. by SEMMA.

Seaweed farming to date has resulted in an average income of USD 470/person/year for those involved (J. Sachak pers. comm.). Although not a great sum, this must be viewed in the context of labour input – seaweed farming involves about 10-12 days work per month, i.e. six months per year, and therefore can be viewed as a supplementary livelihood. It should also be noted that the current income of many people in the area is under USD 2 per day.

Value chain analysis carried out by SEMMA concluded that seaweed farming is economically

Table 1. Individual (one farmer) economic returns for crab and seaweed farming in Tanga (ACDI/VOCA 2007a; ACDI/VOCA 2007b).

	Return (USD)	Number of Units	Investment Days
Crabs	150	100 crabs	45
Seaweed	40	100 lines á 20m	30

viable if conducted on a large enough scale, so that farmers individually produce enough harvest, and are able and prepared to reinvest income into their own farms, e.g. into infrastructure such as lines, rather than relying on buyers to provide these inputs as is currently practised. Typically a local seaweed farmer will grow 100 lines, each 20m long (Table 1). Currently 501 individual farmers are engaged in this, with a total annual production worth USD 27,600. SEMMA are now recommending more commercially sized farms of 400 10m long lines, placed in four blocks which are harvested in sequence over a two-month period (J. Sachak pers. comm.), and are promoting this among 850 farmers. This could yield 370t/month, worth a total of USD 630,480 per year, providing each farmer with USD 644 per year. SEMMA are now also promoting the deeper water raft system for growing seaweed, which is said to enhance growth.

Economic analysis has shown that crab farming has higher returns than seaweed farming (Table 1). Crab demand in Tanga is relatively high, presenting an opportunity for commercial production – a local private buyer/exporter is willing to purchase 500 crabs a week weighing between 500 g and 1000 g each (Sachak pers. comm.), and a buyer from Dar es Salaam is now buying large (>1000g) crabs for export (pers. obs.). A stock assessment, carried out by Tanzania Fisheries Research Institute (TAFIRI) on behalf of SEMMA, established that there is an adequate crab larvae supply and reservoir in Putini and Pangani basins (Mahika et. al. 2005). On the strength of this SEMMA has promoted crab fattening, whereby young crabs are captured in the wild and then fattened in individual wooden cages constructed in the mangroves (see photo above). To increase profits and optimise time consumption as a resource, farmers are being encouraged to fatten crabs individually rather than in a group.

Members of Bweni women's group in Pangani District have increased their profits by 50% since they embarked on crab fattening in 2006, compared with what they used to earn from activities such as selling firewood. However, other groups stated they had not made sustainable profits from milkfish, crab or seaweed culture due to the small scales of production, lack of physical and technical inputs, lack of suitable markets and financial constraints.

Photo: Old salt pans converted to milkfish ponds in Tanga region (© M Samoily).



Table 2. Milkfish and seaweed production by two groups in Pangani district, Tanga Region, with approximate income per person per investment period and 30-day month in Tanzania Shillings and US

Group name	Members	Mariculture type	No. Units	Invest. Period	Income/pers/ invest.period	Income/pers/ month
Machui Women's group, Machui	65	Milkfish	two ponds á 1200 m ²	6 months	TZS 211,200 USD 192	TZS 35,200 USD 32
Amasa Women's group, Kiwavu	11	Seaweed	<100 lines	45 days	TZS 49,500 USD 45	TZS 33,000 USD 30

3.4 Mariculture site visits in Tanga

Mariculture related activities are practiced widely on a small scale in Tanga. Three community groups were visited as part of this study for consultation and discussion, including two community groups in Pangani District practicing milkfish pond farming, crab fattening and seaweed farming on a small scale in tandem with their other daily activities, as well as a fisher group dedicated to lobster catch enhancement. The site visits provided information on typical locally operated mariculture initiatives, their successes and constraints.

3.4.1. Milkfish culture in Machui village

Villagers from Machui in Pangani district, dependent on fishing but also engaged in mangrove cutting and salt making to earn their living, started a welfare group in 2005 for mariculture development. The group was initially mostly made up of women, though more men joined with time. The five milkfish ponds, established in a former saltpan, have a number of problems: drainage is poor, and dykes often collapse. It is clear that pond construction requires different skills to the masonry approach used by the villagers, especially in ensuring that dykes are well compacted and elevated at proper angles, and that the bottom of the pond is compacted and flattened correctly. Production is below levels that should be possible at this site (Table 2).

According to the villagers, TCZCDP was involved in the beginning though little technical assistance was given. Currently the Tanga Municipality Fisheries Officer is providing technical support and occasionally assists in transporting fish to the market. Group members identified a need for more financial and technical assistance in the construction of more ponds and repair of the current ones. However, no suggestions were provided with regards to self-financed maintenance and expansion in the longer term, and requests were limited to direct aid from the government. SEMMA is playing a relatively minor role in milkfish farming in the area because there is no hatchery available and many of the existing ponds in the region have been poorly constructed and therefore require substantial overhauling to get them into proper production.

3.4.2 Crab and seaweed culture in Kiwavu village

Crab culture in Kiwavu village, Pangani District, was started in 2005 by 11 villagers, including 3 men. Both crab and seaweed farming are perceived to be "women's jobs" in this village, probably due to the low incomes associated with small scales of production. With assistance from TCZDP, crab fattening started off with 14 crabs, growing to 200 in the next stock. Unfortunately the crabs were stolen, making the group members lose hope. To date they are still unsure whether to proceed, and at the time of our visit, the cages were empty. The villagers were also discouraged by the low prices their produce fetched, TZS 990/kg (USD 0.8/kg). However, this was largely due to failure to meet quality requirements.

Women in the group also engage in seaweed culture although production is still low, and consequently returns are around one dollar per person per day during growth periods (Table 2). However, they intend to continue with seaweed having developed the required skills. Again, a need for financial inputs from the

government was expressed, but with little consideration of other options such as microcredit and self-investment in the business. The overall understanding of business practice is poor and clearly holding back mariculture development in the area, although understandably perceived opportunities for soliciting donor funds are always explored.

3.4.3 Lobster aggregating devices in Kigombe village

The project was initiated in Kigombe, Pangani district, by TCZDP, not as a mariculture initiative but to enhance fishing by aggregating lobsters through construction of shelters. Shelters made from rocks within the fishing grounds create an ideal habitat for lobsters as they provide protection.

Fishers reported improved catches as a result of the initiative. During the peak periods of lobster capture each year members reported total catches of about 500 kg, worth TZS 10 million. This is equivalent to TZS 5,556, or USD 4, per person per day (i.e. during 6 months of the year). However, conflict with other gear users and vandalism were reported as major challenges.

3.5 Challenges facing mariculture production in Tanga

A number of challenges for the mariculture activities currently underway in Tanga Region are evident. The following were listed as major challenges for the area by Match Maker Associates Limited/EPOPA Tanzania (2005):

- harsh weather conditions and poor soils (high permeability in some areas);
- overexploitation and depletion of coastal resources;
- biodiversity and wetland (including mangroves) habitat loss;
- inefficient use of resources including time, low literacy levels and lack of entrepreneurial drive;
- disparities in gender equity against women; and
- absence of stock assessment of marine products.

Our investigations revealed further rather specific problems and challenges, depending on the type of mariculture activity. Lack of attractive markets and market access was a common challenge experienced by all. While seaweed culture remains labour intensive and a potential source of conflict, it has considerable potential to benefit villagers if scaled up. However, inadequate access to farm inputs appears to be a major constraint to expanding production. Common among milkfish, shrimp and crab were inadequate seed availability and failure to meet market requirements e.g. in terms of quality. Milkfish and prawn culture initially require high labour inputs especially in pond construction and stocking. Currently, there is fear of disease outbreak in prawn culture ponds that can eventually spread to the wild, causing threat to the wild stock and healthy seed availability. Such fears may be unfounded, but require attention. Even though many conditions are favourable for mariculture development, continuous capacity building is still needed to elevate knowledge and business skills among interested parties in the region (ACDI/VOCA 2007b).

4. Conclusions

The main findings of this case study are summarized in two sections below, focusing on the primary focal areas of dynamite fishing and mariculture, and key recommendations are provided.

4.1 Dynamite fishing

Tanzania's large artisanal fisheries are intimately linked to the high biodiversity and productivity of its coral reef ecosystems. However, due to dynamite fishing the livelihoods of many artisanal fishers are under significant threat in many areas. Dynamite fishing destroys the very basis of the ecosystem – the corals that build the reefs – leading to significant loss of biodiversity and fisheries productivity. Continued blasting can

completely destroy a healthy reef, which may never recover and shift to an algal dominated reef of lower species diversity and whose productivity in terms of fisheries is greatly reduced. This destructive fishing practice is now also posing a serious threat to the recently developing coastal tourism sector in Tanzania.

Dynamite fishing in Tanzania dates back about 50 years, and is now an organised practice, whereby boats and dynamite are provided by a “businessman” who employs fishers as crew. Yields are high compared with most traditional fishing methods, but can not be sustained in the long-term. The resurgence of dynamite fishing in Tanga in 2004/5, having been almost eliminated for almost a decade through effective enforcement patrols coordinated by the TCZCDP, appears to be linked to easy access to explosives, the withdrawal of the Navy from the local patrol units, ineffective and inadequate patrolling and monitoring by the government, and withdrawal of the large donor funded TCZCDP. However, it also seems clear that failure to successfully prosecute suspected dynamite fishers and their backers creates an enabling environment, and inefficiency of the judicial system is now commonly cited as a central reason to continued dynamite fishing by many stakeholders, along with collusion by individuals in the administration and/or enforcement agencies. While poverty can not be seen as a major cause for dynamite fishing it has undoubtedly contributed to the problem. It should be noted that only a minority of coastal fishers engage in this practice, most fishers are strongly opposed to it and well aware of its long-term destructive impacts.

Recent responses by government and concerned citizens include increased government led patrols, local community networks that monitor blasting and vigorously publicise the issue, and a high-level government meeting in December 2007. However, in spite of this dynamite fishing has continued unabated. It would appear that the nature of dynamite fishing is well understood by the state and the various communities in the region. Part of the failure to tackle this pernicious practice effectively may relate to too much emphasis being placed on enforcement, which has invariably been difficult and expensive, and has not been maintained at intense levels over sufficiently long periods of time. Mechanisms for encouraging compliance are likely to have greater effect in the long term, if implemented in connection with and as a complement to enforcement.

We recommended that the some of the other enabling factors that allow this practice to continue in Tanga (and elsewhere) are addressed as a matter of priority, including the easy access to explosives and blasting caps, the lack of capacity in the judicial system, as well as its inefficiency. The community consultation lessons learning workshop (section 3.1.2) called for an increase in the severity of penalties for offenders as a deterrent. It is noteworthy that punishments meted out to convicted dynamite fishers are frequently, if not always, below the minimum sentences as per the Fisheries Act 2003. Recognizing this, it is recommended that the courts and responsible government, region and district departments be strengthened, and that they should work closely with local conservation committees and stakeholder groups. Community representatives also emphasized that, to increase transparency and participation, local people should be more directly involved in both enforcement and other management activities of the Fisheries Division and its Officers.

4.2 Mariculture

The dominant mariculture initiatives in the villages around Tanga Region have evolved as a result of suitable coastal habitats found in the area: milkfish pond farming is carried out in the salt flats behind the mangroves; crab fattening in the mangroves; and seaweed farming in shallow waters off sandy beaches. All initiatives are small scale at the household or village level, and communities have engaged in these practises largely due to encouragement and support from NGO/donor programmes, such as TCZCDP and SEMMA, with fairly modest government support.

It is important to note that none of the existing animal-based mariculture initiatives in Tanga constitutes true mariculture because they are not breeding the organism – there are no hatcheries in Tanzania. Juvenile organisms are harvested from the wild and grown out. This is relevant as the animals ‘cultured’ are also harvested as part of the local fisheries, especially crab and lobster. Initiatives should therefore be seen as mechanisms for either value adding to an existing fishery or for enhancing catching efficiency.



Photo: Village women engaged in mariculture, Tanga region (© M Samoily).

Consequently such practices must be managed hand in hand with the management of the wild stock. They do not enhance production in the marine environment, and should not be seen as separate mariculture industries, a fact not well comprehended by most stakeholders. Awareness on the implications of this needs to be enhanced throughout the area and among all stakeholders.

The plant based seaweed farming is an exception, as locally harvested wild species are not used. However, since the algae used are exotic, imported from the Philippines, there is potential for invasion in Tanzania's marine environment. Such invasions have been documented in other parts of the Indian Ocean where they have been introduced for aquaculture, with significant negative impact on native biota. To date there is no evidence of this occurring in Tanzania, and it is generally assumed that the two species introduced do not have invasive tendencies and/or are outcompeted in the wild by locally occurring species. However, specific research on this has not been done and is recommended, including careful risk assessment and development of management and mitigation strategies should further non-native species be considered for use.

It was clear from the interviews and site visits that community based milkfish, crab and seaweed culture are not yet creating significant and sustainable profits due to the small scales of production, lack of physical and technical inputs, lack of capacity to meet market quality and quantity demands, in some cases lack of suitable markets and market access, and other financial constraints such as shortage of investment capital. These were all mentioned in the community lessons learning workshop (section 3.1.2) and some recommendations for addressing them were provided, largely calling on government to recognise the industry as a mechanism for addressing poverty, and to exert less control over buyers and markets.

The industry has great potential for addressing food security and income generation but substantial effort is now required to build capacity, provide technical inputs, and ensure small scale mariculture in Tanga is developed through learning lessons from South East Asia and South America where the industry is

considerably more advanced. This includes scaling up ventures, using different species and innovative and integrated approaches, but also instilling more solid business management practices and addressing problems of financial management and cash flow. Notably, the onerous EIA requirements in Tanzania are seen as an impediment, and reviewing these, facilitating ventures in carrying out EIAs and expediting the process of vetting EIAs may help promote development, without compromising environmental sustainability.

Technical capacity within District administrations to provide adequate extension services is limited. Considering the fast pace of development in this industry globally, it is not surprising that local government extension officers are challenged to keep up, a problem faced also in developed countries, where services offered by extension officers in aquaculture are rarely adequate. It is recommended that this situation be recognised more broadly and that the government in providing this service more closely engages NGOs and civil society organizations specialising in community based mariculture, through outsourcing or other means. SEMMA is well placed to provide such a service in Tanga town and beyond, and should be recognised for this.

Mariculture is still relatively undeveloped in Tanga region, and thus its impact on coastal peoples' livelihoods to date is difficult to assess overall, but is mostly limited to the people directly engaged. Certainly women have benefited from seaweed farming, which although practiced on a small scale provides cash income roughly double what is earned from other common activities. The young men running a crab-fattening group venture in Pangani reported substantial improvements in their incomes. In general, though, quantitative monitoring of the impacts of mariculture, whether in terms of improved socioeconomic wellbeing of coastal communities or reducing pressure on marine resources, is lacking. It is highly recommended that well designed monitoring and assessment protocols are put in place to record impact of mariculture in Tanga Region, including to support and advise further mariculture development to ensure this can benefit both natural resource management and community development.

Photo: Fisherman, Tanga region (© M Samoilys).



5. References

- ACDI/VOCA 2007a. Quarterly Project Report, January-March 2007. SEMMA, Tanga, Tanzania.
- ACDI/VOCA 2007b. Quarterly Project Report, April-June, 2007. SEMMA, Tanga, Tanzania.
- ACDI/VOCA 2008a. SEEGAAD: Alleviating Poverty & Countering Environmentally Unsustainable Practices. URL: <http://www.acdivoca.org/acdivoca/PortalHub.nsf/ID/tanzaniaSEEGAAD>
- ACDI/VOCA 2008b. SEMMA: Developing Economically Viable & Environmentally Sustainable Income-Generating Activities. URL: <http://www.acdivoca.org/acdivoca/PortalHub.nsf/ID/tanzaniaSEMMA>
- Al-Samarrai, S. and B. Reilly. 2005. Education, employment and earnings of secondary school leavers in Tanzania: evidence from a tracer study. PRUS Working Paper No. 31, Poverty Research Unit, University of Sussex, UK.
- Anon. 2005. Tanga Integrated Rural Development Programme (TIRDEP), Tanzania. Summary Ex-post Evaluation. Country Case Study. BMZ Evaluation Report 007, Division of Development Education and Information, Sustainability of Regional Rural Development Programmes (RRD), Federal Ministry for Economic Cooperation and Development.
- Becha H. 2008. National workshop for building the capacity of coastal communities and strengthening policy for the sustainable management of Tanzanian marine resources. Workshop, 28 – 31 January 2008, Tanga Regional Coastal Resource Centre. Workshop Report. CORDIO/IUCN. 32pp.
- Bensted-Smith, R. (Ed). 1988. The Coastal Resources of Tanga Region, Tanzania. Report of a Preliminary study in October 1987. Regional Natural Resources Office, Tanga Region and IUCN-EARO. 51 pp.
- Bryceson, I. 1978. Tanzanian coral reefs at risk. *New Scientist* 80: 115.
- CCIF 2001. Analysis of Destructive Reef Fishing Practices in the Indo-Pacific. Conservation and Community Investment Forum (CCIF) Marine Program, San Francisco, USA.
- Guard, M. and M. Masaiganah 1997. Dynamite fishing in southern Tanzania, geographical variation, intensity of use and possible solutions. *Marine Pollution Bulletin* 34(10): 758-762.
- Harrison, P., (2005) A Socio-economic Assessment of Sustainable Livelihoods Regimes for Communities of Mnazi Bay Ruvuma Estuary Marine Park, Tanzania: Incorporating livelihood intervention strategies and proposals for the development of Alternative Income Generating Activities. IUCN EARO, Nairobi.
- Horrill J. C. 1997. Case study of collaborative fisheries management in Tanga Region, Tanzania. IUCN Wetlands Programme, Gland, Switzerland.
- Horrill J. C., Kamukuru A. T., Mgaya Y. D., Risk M. and J. Church. 2000. Northern Tanzania, Zanzibar and Pemba. In: McClanahan T. R., Sheppard C. and Obura D.O. (eds.) *Coral Reefs of the Western Indian Ocean: Their Ecology and Conservation*. Oxford University Press, New York.
- Horrill J. C., Kalombo, H. and S. Makoloweka. 2001. Collaborative reef and reef fisheries management in Tanga, Tanzania. IUCN EARO, Nairobi. 37pp.
- Horrill, J. C. 1996. Coral reef survey: summary report. Tanga Coastal Zone Conservation and Development Program, Tanga, Tanzania.
- Ireland C. Malleret D. and L. Baker. 2004. Alternative Sustainable Livelihoods for Coastal Communities – A Review of Experience and guide to Best Practice. IUCN-EARO, Nairobi.
- Mahika C., Mhithu H. and B. Kuboja. 2005. Rapid Assessment of Abundance and Biomass of the Mangrove Crab (*Scylla serrata* L.) and its Mariculture Development on The Tanga Coast. ACDI/VOCA, Tanga.
- Match Maker Associates Limited/EPOPA Tanzania. 2005. Sub Sector and Value Chain Analysis for Mud Crabs Tanga Coastal Belt. Final Report, Tanga.
- McClanahan, T.R., Muthiga, N.A., Kamukuru, A.T., Machano, H., and R. Kiambo. 1999. The effects of marine parks and fishing on the coral reefs of northern Tanzania. *Biological Conservation* 89: 161-182.
- McCook L.J. 1999. Macroalgae, nutrients and phase shifts on coral reefs: scientific issues and management consequences for the Great Barrier Reef. *Coral Reefs* 18: 357-367.
- Mzava E., Mbura M., Bwindiki J., Uronu G., van Ingen T., and S.Wells. 2007. Capacity development In: Wells S., Makoloweka S. and Samoilys M. (eds.) *Putting Adaptive Management into Practice: Collaborative Coastal Management in Tanga, Tanzania*. IUCN-EARO, Nairobi.
- Obura, D. (2005) East Africa – Summary. Pp. 25-31 In: Status Report, Coral Reef Degradation in the Indian Ocean. CORDIO/IUCN/SIDA.

- Obura D., Suleiman M., Motta H. and M. Schleyer. 2000. Status of Coral Reefs in East Africa: Kenya, Mozambique, South Africa and Tanzania. In: Wilkinson C. (ed.) Status of Coral Reefs of the World: 2000. Australian Institute of Marine Science, Queensland, Australia.
- Pet-Soede C., Cesar H. S. J. and J. S. Pet 2000. Economic issues related to blast fishing on Indonesian coral reefs. Indonesian Journal of Coastal and Marine Resources. 3(2): 33-40.
- Ray G.C. 1968. Marine Parks of Tanzania. Conservation Foundation, Washington D.C.
- Riedmiller S. 2006. Dynamite fishing rampant in Tanzania's north coast (opinion and Analysis). The Citizen, Friday, 3 Nov, 2006. Tanzania.
- Samoilys M., Horrill C., Kalombo H, Kabamba J, and S. Wells. 2007b. Coral reefs and mangroves: maintaining ecosystem health. In: Wells, S, Makoloweka, S, and Samoilys M. (eds.) *Putting Adaptive Management Into Practice: Collaborative Coastal Management in Tanga, northern Tanzania*. IUCN-EARO. pp: 77-102.
- Samoilys M., Wells S., Anderson J., Horrill C., Kalombo H. and E. Verheij. 2007a. Fisheries and their management in Tanga region. In: Wells S., Makoloweka S. and Samoilys M. (eds.) *Putting Adaptive Management into Practice: Collaborative Coastal Management in Tanga, Northern Kenya*. IUCN-EARO, Nairobi. pp.46-76.
- Samoilys M.A. and G. Carlos 1992. Development of an underwater visual census method for assessing shallow water reef fish stocks in the south west Pacific. ACIAR Project PN8545 Final Report, April 1992. 100pp.
- Samoilys M.A. and Kanyange N.W. 2008. Natural resource dependence, livelihoods and development: Perceptions from Kiunga Marine National Reserve, Kenya. IUCN ESARO 2008.
- Samoilys, MA 1988. Abundance and species richness of coral reef fish on the Kenyan coast: the effects of protective management and fishing. Proc. 6th Int. Coral Reef Symp. 2: 261-266.
- Savoie, R. 2005. SEEGAARD. Progress Report, January-March, 2005. Tanga, Tanzania.
- Scheinman D. and A. Mabrook. 1996. The Traditional Management of Coastal Resources. Consultancy report to TCZCDP. 77 pp.
- Solandt J-L. and M. Beger. 2000. A study of the key anthropological and physical impacts that occur on the reefs of Danjungan Island, Negros Occidental. Danjungan Island Survey Summary report 1, PRRCFI. Bacolod, Philippines.
- Talbot, F. 1960. Notes on the biology of the Lutjanidae (Pisces) of the East African coast, with special reference to *L. bohar*. Annals of the South African Museum 45: 549-573.
- Verheij E., Makoloweka S. and H. Kalombo. 2004. Collaborative coastal management improves coral reefs and fisheries in Tanga, Tanzania. Ocean and Coastal Management 47: 309-320.
- Vincent A.C.J. 2006. Reconciling fisheries with conservation on coral reefs: the world as an onion. In: J. Nielson. (ed.). Proceedings of the 4th World Fisheries Congress, Vancouver, 3-6 May 2004. American Fisheries Society Symposium 49:587-620.
- Wells S., Horrill C., Kalombo H., Kabamba J., and E. Verheij. 2007c. Collaborative Management Area Planning. In: Wells S., Makoloweka S. and Samoilys M. (eds.) *Putting Adaptive Management into Practice: Collaborative Coastal Management in Tanga, Tanzania*. IUCN-EARO, Nairobi. pp. 22-45.
- Wells S., Makoloweka S. and M. Samoilys (eds.) 2007a. *Putting Adaptive Management into Practice: Collaborative Coastal Management in Tanga, Tanzania*. IUCN-EARO.
- Wells S., Samoilys M. and S. Makoloweka. 2007d. Conclusions and lessons learnt. In: Wells S., Makoloweka S. and Samoilys M. (eds.) *Putting Adaptive Management into Practice: Collaborative Coastal Management in Tanga, Tanzania*. IUCN-EARO, Nairobi. pp. 170-185.
- Wells S., Samoilys M.A., Anderson J, Kalombo H, and S. Makoloweka 2007b. Collaborative Fisheries Management in Tanga, Northern Tanzania. In: McClanahan TR and J.C. Castilla (eds) *Fisheries Management: Progress towards sustainability*. Blackwell. pp. 139-165.
- Woodman G. H., Wilson S. C., Li V.Y.F. and R. Renneberg. 2004. A direction-sensitive underwater blast detector and its applications for managing blast fishing. Marine Pollution Bulletin 49, 964-973.
- Yussuf, I. 2007. Dynamite fishing writer provokes furore in Z'bar. <http://ippmedia.com/ipp/guardian/2006/11/20/78754.html>
- Zuberi L., Urio F., van Ingen T. and S. Wells. 2007. Enhancing livelihoods. In: Wells S., Makoloweka S. and Samoilys M. (eds.) *Putting Adaptive Management into Practice: Collaborative Coastal Management in Tanga, Northern Kenya*. IUCN-EARO, Nairobi. pp. 103-123.

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