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Monitoring of fish and fish catches by local fishermen in Kenya and Tanzania

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Abstract. Monitoring of fish populations underwater and of fish catches is being undertaken at several sites in Kenya and Tanzania using local names and languages. This paper describes the programmes underway at Kiunga Marine Reserve and Diani-Chale in Kenya, and at Tanga in Tanzania. At all three sites, standard protocols have been adapted for use by local fishermen, who have been trained to collect data. A key factor enabling this has been to use local knowledge as the foundation of monitoring. The paper discusses some of the difficulties encountered, such as variations in the use of names, and generally low literacy among fishermen. Overall, the benefits far outweigh the disadvantages in terms of developing a much greater sense of involvement in, and participation by, the fishing communities in the management of their resources. The programmes are also providing the fishermen with a deeper understanding of the impact of fishing on their resources and thus will help them to apply appropriate management approaches.

Introduction

The role that non-scientists, such as fishers, recreational divers and others, can play in the monitoring of marine resources has gained increasing acceptance. This is partly due to the move from the traditional management approach, focusing on the resource itself, to more holistic approaches that recognize the interaction between people and the environment, and the need to incorporate aspects of human behaviour, as well as political, cultural and socio–economic factors, in resource management. In the context of local villagers, or subsistence resource users, such monitoring is often referred to as 'participatory monitoring', where the word 'participatory' emphasizes the non-technical and essentially voluntary nature of the data collectors.

The rigour and quality of data collected in this way is often questioned, although protagonists point out both its value in situations where the only other option is no monitoring at all, and its role in encouraging stakeholder involvement in management. Fishing communities may feel alienated from marine resource management, particularly if the classic government top-down approach has been imposed. Although this approach is being phased out in many countries, its legacy is still felt in the conflicts that remain between fishing communities and government agencies wishing to regulate fast diminishing marine resources. Also, as is now well recognized (e.g. Johannes 1987; Ruddle 1996), the indigenous knowledge of fishers can be vital to ensuring that correct management decisions are made. Use of this knowledge in monitoring programmes, as well as the skills of resource users, leads to a direct involvement of the users in management decision-making.

Early initiatives towards participatory monitoring involved recreational and volunteer SCUBA divers with a keen interest in coral reefs and conservation working through organizations such as Coral Cay Conservation, ReefWatch, Frontier and ReefCheck (Wells 1995). Increasingly, it is being recognized that similar activities can be carried out by local people and resource users, such as fishers, often more effectively and with potential for more sustainable, long-term impact. A number of programmes of this nature are underway in the Philippines (e.g. Uychiaoco *et al.* 1999). In the present paper, three case studies from East Africa are presented, where monitoring programmes have been developed with the participation of local fishers. The impact of the participatory approach is discussed as well as the benefits and limitations of involving users in monitoring.

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Methods

The sites

The three case studies are in Kenya and northern Tanzania (Fig. 1). The three sites are similar, in that they are characterized by fringing and offshore patch reefs, extensive seagrass beds and shallows, with estuarine mangroves in some areas, but they are culturally and socially different. Nevertheless, the fishing culture is similar, using gear and vessels characteristic of the Swahili-East African coast.

Diani, southern Kenya

The Diani–Chale coral reef area, comprising 15 km of coastline ~20 km south of Mombasa (Fig. 1), supports local indigenous fishing communities as well as an active tourism industry (Rubens 1996; McClanahan *et al.* 1997). The reefs were gazetted as a National Marine Reserve in 1994, under the responsibility of Kenya Wildlife Service (KWS), a designation that allows for traditional forms of fishing. However, conflict with local fishers caused KWS to suspend implementation of the marine protected area (MPA). Fishing in Kenya is regulated by the Fisheries Department under the Fisheries Act, but this is poorly enforced. Fishery resource issues have instead been dealt with through non-formal channels (King 2000), whereby fishermen resort to opportunistic and personal relationships available to them to influence local government decisions. The fishery has been monitored since 1995 by Fisheries Officers (McClanahan *et al.* 1997) and by a participatory monitoring programme started in 1997 involving local fishermen (Obura 2001).

Kiunga, northern Kenya

The 250 km^2 Kiunga Marine National Reserve (KMNR), in Lamu District bordering Somalia, is the most northerly MPA in Kenya (Fig. 1). Prevailing monsoons and tides, coupled with insecurity due to proximity to the Somali border, make fishing and transportation hazardous for half the year, exerting a natural control on fishing and resource use. The site's remoteness constrains the market for fish from the area, with cold-storage boats travelling 300 km from Mombasa to buy fish and crustaceans. The Reserve was gazetted in 1979, and is managed by KWS on behalf of the Lamu County Council. As in the case of Diani–Chale, this designation allows traditional fishing. However, in this case the Reserve was accepted by the local Bajuni, largely because the Lamu County Council openly recognized their 'traditional' marine user rights. As in Diani, the Fisheries Department has been seriously constrained by lack of personnel, equipment and boats and, although fish catch data have been collected, fish stocks and reef habitats were not monitored until a participatory monitoring programme was initiated by KWS and the World Wide Fund for Nature (WWF) in 1997.

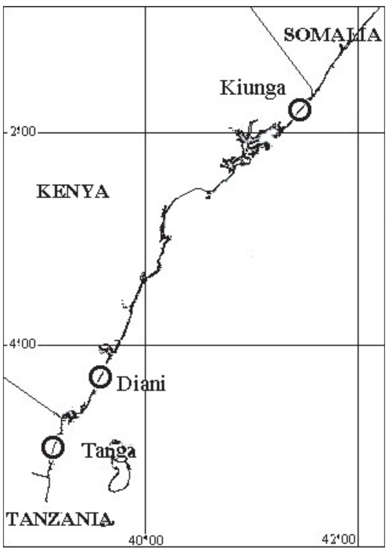

Fig. 1. Map of study sites.

Tanga, northern Tanzania

Tanga Region is the most northern coastal region of Tanzania and encompasses three coastal Districts, stretching 180 km south from the border with Kenya (Fig. 1). The human population of ~379 000 live in two towns and 42 coastal villages, and fishing is one of the primary uses of marine resources. The marine and coastal resources are managed through the Tanga Coastal Zone Conservation and Development Programme (Tanga Programme) in a collaborative arrangement between the District Authorities and the coastal villages. Initiated in 1994, the Programme places particular emphasis on fisheries management and has facilitated the establishment of five collaborative reef and reef-fisheries management initiatives, with another being negotiated (Horrill *et al.* 2001).

Participatory monitoring methods

At each site, three types of participatory monitoring have been or are being established (Table 1): catch monitoring, underwater fish counts and ecological monitoring of the substratum. For the fishers, catch landings are easiest to monitor; underwater fish counts and substratum monitoring require more training.

Table 1. Participatory monitoring programmes underway at each site, with their start date

	Diani, Kenya	Kiunga, Kenya	Tanga, Tanzania
Fish catch	1997	2000	1995
Underwater visual fish census	2001	1999	1998
Substratum monitoring	[2002 planned]	1999	1998

Catch monitoring

At all three sites, catch monitoring has been the primary monitoring activity, and the methods were developed in consultation with the fishers themselves. In general, the data collectors were selected by the fisher groups or local communities, and the groups are the custodians of the original field notebooks. At all three sites, units for measurement were selected that were consistent with fishers' practices and only local names were used for gear, sites and fish taxa. In Kiunga, catches are often measured on the boats before they pass to a trader's boat because there are few landing sites.

Underwater visual census of fish

The fish census methods at all three sites are adapted from standard and widely used methods (English *et al.* 1994; McClanahan *et al.* 1999) using belt or line-intercept transects. Local names are used for the taxa, and other adaptations are made as required. For example, in Kiunga, size classes are defined as 'hand', 'forearm', 'elbow' and larger, according to the measuring system normally used by fishers. In Kiunga, joint teams of scientists, management staff and fishers carry out the censuses, using both snorkelling and SCUBA diving. In Tanga, village monitoring teams have been trained in the methods by scientists and now require little external assistance; snorkelling only is used.

Substratum monitoring

The monitoring of benthic habitats is adapted from the methods used for the fish census work. In Tanga, for example, the monitoring teams have been trained to record percentage coral cover and urchin density, and presence of commercially or ecologically important species (crown of thorns starfish, octopus and lobster). Simplified categories for line-intercept work and local names are used wherever possible.

Data storage and analysis

In Tanga, data are stored and analysed in a purpose built database designed so that data can be entered by members of the monitoring teams, and the analysis is carried out by local government officers. At Kiunga and Diani, data are analysed by technical staff in the associated scientific and management institutions, but work is underway to develop similar site-specific databases that can be used at the local project level. At all sites, the results of the monitoring work are shared on a regular basis with the local villagers, and trends are shown and the causes discussed.

Training and validation

Because participatory monitoring involves dialogue and reciprocal learning between fishers and scientists (or managers), training is not conducted in one brief period of time, and is hands-on in the field. In Diani, 4 months were necessary to develop a suitable catch-monitoring protocol, with the result that the first 4–6 months of data were unsuitable for analysis. True validation of data collected is desirable in the long term. In the Tanga project, scientists in the Institute of Marine Sciences validate data collected annually by working with the team and comparing their data with those collected by the fishers. Regressions of live coral cover, urchin density and fish count data using the scientist's values as the independent variable and those of the monitoring team as the dependent variable show good agreement, with slopes approaching 1, intercepts 0 and R^2 values of ~80%. Values may differ but not significantly.

Results

The datasets compiled so far in these three projects are too short for in-depth analysis. However, the longer data sets (catch monitoring at Diani (4 years) and Tanga (6 years) and underwater visual census of fish (3 years in Tanga) provide some preliminary results, and show how the information can be used in management interventions.

Data collected by the Diani fishermen provide information on total catch and catch per unit effort. Fig. 2 shows daily catch per fisher averaged by month, for the main gear types. The overall catch fluctuates for the four-year period between 2 and 4 kg fisher^{-1} day^{-1}, with approximately annual cycles showing maximum catch in November–April during the north-east monsoon and minimum catch during June–August during the rough south-east monsoon. In spite of claims by fishers of greater catches by certain gears rather than others, the five main gear types in Diani catch remarkably similar quantities of fish, with higher peaks for nets and greatest success for spearguns from November 2000 onwards. These data have been used to show fishermen that their perceptions about catches with different gear types may differ from the real catches. The steep rise in catch recorded from April to July 1998 is most likely an artifact of sampling, illustrating the need for a prolonged training period until data may be suitable for analysis.

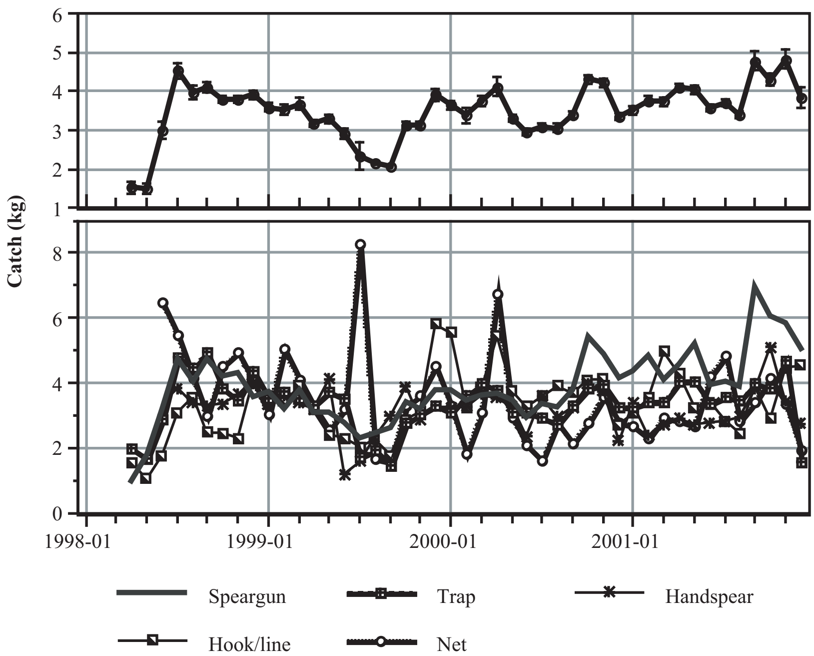

Fig. 2. Diani, Kenya. Monthly summary of catch monitoring data (kg fish fisher^{-1} day^{-1}) for 1998–2001: *(above)* all gears (mean ± s.e.); *(below)* catch (mean) by the five most common gear types.

Underwater visual census of fish at Tanga started before the closure of certain reefs to fishing and the elimination of destructive dynamite fishing. The monitoring programme has demonstrated an increase of benthic and schooling commercial fish species on both open and closed reefs (Fig. 3), with larger increases on the closed reefs. It is not possible to say conclusively that these changes were due to management, but it seems likely that there is a relationship in some cases, for example, between the increase of benthic and schooling commercial fish and the cessation of dynamite fishing. This may also be the cause of an increase in net catches documented by the catch monitoring programme, especially for pull-seine nets, which may be catching juvenile fish that were previously killed by dynamite fishing.

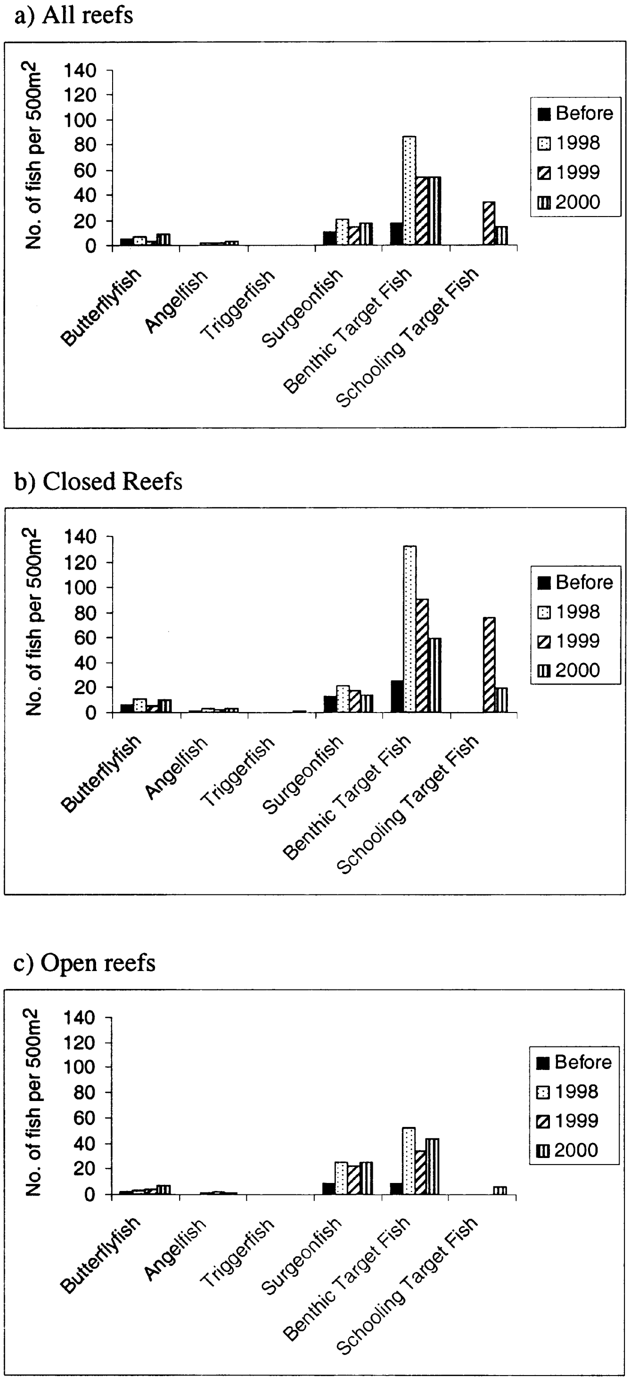

Fig. 3. Tanga, Tanzania. Mean number of fish per 500 m^2 for *(a)* all reefs, *(b)* closed and *(c)* open reefs before management actions were implemented and for subsequent years after implementation.

Discussion

Impact of participatory monitoring

At all three sites there have been a number of positive impacts. In all three programmes, scientists, local government officers and communities take part in the collection, analysis and presentation of data, which has led to much sharing of information and ideas. In Tanga, participatory monitoring is considered a key factor in the success of the collaborative reef and reef-fisheries management plans (Horrill *et al.* 2001). At Kiunga, through collaborative management with the KWS, Fisheries Department and local fishers, participatory monitoring is considered fundamental to current and future fisheries management within the MPA. At Diani, in the absence of a formal structure for marine resource management, it has not been possible to use monitoring data in decision making, but the fisher groups involved have been at the forefront of dialogue with other stakeholder groups and government officials. Three main effects have been identified: increased awareness of the need for management, improved management (as a result of this better understanding), and community empowerment to advocate for good management.

Increased awareness

At all sites, regular monitoring of fish catches has raised awareness among fishermen of the need for fisheries management and of the impact of fishing activities. It has also improved their understanding of reef and fish ecology. As a result of monitoring, fishermen make increasingly frequent references to the causes and effects of declining fish catch or degraded reef sites, and use these arguments in discussions with sceptical fishers, government officials and others. In all three sites, discussions based on the monitoring data have helped communities understand global issues such as coral bleaching.

Improved management of resources

Understanding of the data being collected is a critical component to successful participatory monitoring. In Tanga, the database allows technical information to be made available for presentation to villagers 24 h after completion of sampling. This has greatly facilitated the adaptive management cycle used by the Programme and has enabled very immediate changes in policy and legislation. For example, data showing catch trends with different gear types was presented to key decision makers and politicians at local and national levels, resulting in a successful gear exchange scheme being implemented, which replaced damaging pull-seine nets with other gears such as gill-nets and traps.

Participatory monitoring may also contribute to the willingness of fishermen to establish closed areas to protect breeding fish stock. Both in Tanga and Kiunga, villages have used information from the monitoring programmes to identify reefs for full or partial closure. In Tanga, the subsequent monitoring then demonstrated the positive impact of the closures.

Regular monitoring has also encouraged fishers to report illegal and damaging fishing activities, and to demand improved law enforcement by government authorities. In Diani, where the use of beach seines escalated, one of the monitoring groups requested a survey of this (Obura *et al.* 2001) and action by the Fisheries Department. In Kiunga, fishers now participate in a joint patrol team with the Fisheries Department, KWS and WWF, and reporting on and apprehension of illegal fishers has increased.

Empowerment of communities

At all three sites, building capacity within the communities for collection, analysis and dissemination of technical information has considerably strengthened their ability to participate in the management of their own resources. The provision of information, and the improved local knowledge of monitoring teams are becoming valued at the village and district levels. In Tanga, key decision makers within the communities now seek the advice of the monitoring teams as to what action should be taken. The phrase '*Wataalum wetu wanasemaji?*' (What do our experts say?) is now increasingly heard during management plan reviews. For example, monitoring of fish prices led to greater awareness of how the village government used revenue from the sale of fish, octopus and lobster. In one case, this resulted in fishers refusing to pay tax on their catches until the village government accounted for previous revenue which should have been used for community development projects; this ultimately led to a change in that village government.

In Diani and Kiunga, where monitoring datasets are shorter, the process of monitoring has spawned a number of 'fringe' benefits related to group organization and empowerment. The collection of monitoring data has been a strong stimulus for fishers to organize into community groups, which are now serving many of the functions of previous fishing co-operatives, which had collapsed in Kenya as a result of political and financial problems. The new 'self-help' groups have evolved along individual lines and, as well as participatory monitoring, are variously involved in discussions with government authorities, raising funds through membership dues and then investing in boats and gear for members and trying to secure land title to preserve their access to the sea.

Constraints and limitations of participatory monitoring

Data quality

Some parameters have proved difficult for non-scientists to monitor as a result of different education levels, perceptions and knowledge. Low education and literacy levels among fishing communities are a significant barrier, because data must be written. Inclusion of at least one literate fisher in a monitoring team is therefore necessary, and communication is only a real problem during SCUBA diving when conversation is not possible. Appropriate design of data sheets can also be used to reduce dependency on literacy.

Teaching fishers to distinguish different benthic and algal types is proving difficult in Kenya, and use of Latin names for taxonomic groups and other scientific terminology creates problems. Experienced fishers are good at identifying fish and invertebrates, and have extensive knowledge of geographical and other factors such as distribution and seasonality. Adapting a monitoring programme to this local knowledge may be more effective than trying to train fishers to use unaltered scientific terminology and definitions.

One problem is that local fish names do not always correlate directly with scientific taxa. Some correspond to species, others to higher taxonomic levels such as genera and families, others to mixed groups of species, and some species and groups have several names (Table 2). This is particularly difficult if a general name is used for a large and diverse group (e.g. 'changu' for snappers, Lutjanidae) that contains a number of important fishery species with local species-specific names (e.g. 'mbavaa' for *Lutjanus fulviflamma*), names for smaller subsets of species, and even different names for different size classes and sexes of individuals within a species. In addition, these names may differ among different fisher communities.

On the positive side, identifying fish by local names enables focus on particular species and groups of special interest and importance to fishers. Furthermore, data from fishers' surveys can be analysed in a number of ways. Where analysis is needed for comparison with other studies, local taxa can be aggregated to scientific family level. Where the focus needs to be on taxa important to the fishers, local names and taxa can be used. Where scientific species-level analysis is needed, e.g. for information on population biology, more careful selection of taxa is needed. As the fishers become more proficient, more detail could be collected during the monitoring by adding descriptive terms to local names in order to distinguish all biological species. As illustrated by the Tanga village monitoring teams, local

Table 2. Kiunga, Kenya. Local fish names and their scientific counterparts

Local names may correspond to biological species or biological families, or may include fish of different families and combinations of species

Local name	Scientific name	English name
Species specific		
chuku	*Lethrinus mahsena*	Sky emperor
tangu mbaa	*L. harak*	Blackspot emperor
ichawa	*L. nebulosus*	Spangled emperor
tazanda	*Lutjanus argentimaculatus*	Mangrove snapper
kungu	*L. bohar*	Twinspot snapper
keusi	*L. rivulatus*	Scribbled snapper
shogo	*L. sanguineus*	Humphead snapper
Family level		
kangaja	Acanthuridae	Surgeonfish
gona	Balistidae	Triggerfish
pono	Scaridae	Parrotfish
tafi/tasi	Siganidae	Rabbitfish
Polyphyletic/mixed		
changu	Lutjanidae	Snappers
	Lethrinidae	Emperors
kipepeo	Chaetodontidae	Butterflyfish
	Zanclidae	Moorish idol
chaluende	*Chaetodon lunula*	Racoon butterflyfish
	Zanclus cornutus	Moorish idol
pono	Scaridae, some Labridae	Parrotfish, with some wrasses
pono mukoma	Scaridae	Parrot fish
mkoma	Mullidae	Goatfish

fishermen once trained can reach levels of accuracy comparable to those of scientists for many of the parameters of interest.

Sustainability

All monitoring programmes face sustainability problems in the areas of funding, commitment and long-term continuity of data collection. Establishment of participatory monitoring programmes may be a slower process than setting up a purely science-driven programme. Participatory programmes need time to develop acceptance by communities, and the first few years of data collection may have to be targeted more towards building relationships than ensuring that scientifically valid data are collected. This is particularly a problem where funding is constrained by 2–3 year project cycles, since scientifically valid results are unlikely to be achievable within this time span. Participatory monitoring also involves training, especially in recording data and in-water procedures, which also takes time. However, if participants are carefully selected (e.g. experienced fishers with good identification skills), training may be shorter than for individuals who are not used to working in water and have never had to identify fish. On balance, the projects have found that training of community members to work with a small number of scientists is more efficient than relying on all-scientist teams for monitoring, given the limited numbers of available scientists in the region.

Long-term financial sustainability is a key concern, with all three case studies currently being supported by external funding. A day spent monitoring by a fisher translates directly into a day's lost income from fishing, and thus all three programmes provide compensation. In the long term a combination of approaches will be necessary, with the costs shared among government, private sector and NGOs. For example, a proportion of fisheries taxes and levies from the area could be used, and commercial companies benefiting from the resources being harvested might be persuaded to contribute. At Tanga, the potential for making monitoring teams into non-profit-making companies is being investigated; these could be contracted by local government to undertake monitoring under the guidance of scientists.

Other potential incentives to participate in monitoring include the development of personal skills (e.g. snorkeling and knowledge of marine life that can be used in the tourism industry) and increased social standing (e.g. from spear fisherman to 'resource expert').

Where human resources, expertise and funding are limited, as in Kenya and Tanzania, monitoring is unlikely to be carried out on a long-term basis if left to any single agency. It has a much higher chance of success if carried out as a collaborative effort, involving the local community, government agencies, scientific institutions and, where appropriate, NGOs, the private sector and other bodies. The Tanga Programme and Kiunga Marine Reserve project are some way to achieving such collaborative mechanisms, with the involvement of scientists, local monitoring teams and relevant government staff, but mechanisms to ensure sustainability have yet to be developed.

Social and political factors influencing the sustainability of participatory monitoring range from the negative effects of divisions within communities to the positive effects of the vision of key individuals.

Conclusions

The Eastern African programmes are still in relatively early stages of development, and need to be seen as part of a broader suite of activities underway in the region to involve local people in the management of marine and coastal resources. In both Kenya and Tanzania, the participatory approach is increasingly being incorporated into national policies on natural resource management, and the institutional and legal frameworks needed to support and underpin community participation are being developed.

Participatory monitoring programmes do not eliminate the need for more scientifically oriented monitoring programmes. They need to be understood as complementary

Table 3. Comparison of local nomenclature and knowledge systems versus scientific knowledge for resource monitoring, in areas related to resource biology, local management and larger-scale management organization
'Larger', larger constraints of using local knowledge than scientific knowledge; 'Comparable', similar constraints of using local knowledge and scientific knowledge; 'Less', fewer constraints of using local knowledge than scientific knowledge

Issue	Constraint
Resource biology:	
Biological species management of a broad range of species	Larger
Biological species management of a restricted range of primary target species	Comparable
Trophic group, family or other higher level management indicators	Comparable
Integration with biological research on target species	Larger
Management:	
Management by size/gear limitations	Comparable
Management by fisher numbers and effort	Comparable
Management by seasons and important reef zone closures	Comparable
Raising education and awareness among fishers and other local communities	Less
Participation and involvement of stakeholders in management	Less
Integration of different management units (eg. districts, countries, etc.):	
With respect to data consistency, nomenclature	Larger
With respect to awareness, communication, etc.	Comparable?

activities that can fill gaps caused by lack of human and financial resources in government and scientific agencies, and that can result in much broader coverage of a country's marine and coastal areas (Table 3). As the case studies show, the main challenge is to develop sustainable partnerships that will provide the institutional and financial basis to make these long-term programmes, rather than activities limited by the life of a 'project', with its external funding and technical assistance. This will require the involvement of local communities, scientific institutions, relevant government agencies and others as appropriate.

Equally important, however, is the 'added-value' of participatory monitoring, in the role it may play in improving resource management, through increased awareness and understanding, community empowerment, and demonstration of successful management interventions. Further case studies and comparisons of similar initiatives will help to identify more clearly the benefits, as well as the constraints, of this approach to monitoring.

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