Support to Marine Research for Sustainable Management of Marine and Coastal Resources in the Western Indian Ocean

The Western Indian Ocean (WIO) region is renowned for the attractiveness of its coastal zones, high marine biodiversity and rich marine and coastal resources. Yet the countries of the region, Kenya, Mozambique, Somalia, South Africa, Tanzania, Comoros, Madagascar, Mauritius, Reunion, and Seychelles, are impoverished, and during the last couple of decades signs of environmental degradation, as well as a decline in natural resources and biodiversity, have become more and more obvious. The environments of the region are threatened by a variety of human activities. Poverty combined with rapid population growth and a poor understanding and management of coastal resources has resulted in a number of environment and resource use problems, including habitat destruction, overexploitation of fisheries resources, human-induced erosion and pollution.

Of the Western Indian Ocean states, 8 of 10 are developing nations which are at different stages of both political and economic development, and a large proportion of the population depends directly on the sustained productivity of the coastal ecosystems for their supply of food. Environmental degradation of these ecosystems will inevitably affect prospects for development and even the survival of the poorest of coastal communities as they often lack alternative income-generating activities. Thus, there is an urgent need for better and more effective management of natural resources to accrue from them the needed goods and services for improving the quality of life of the people, to sustain the economies of the countries in the region, and to maintain the productivity of ecosystems.

Still, compared to most other coastal areas around the Indian Ocean, there are extensive natural areas that are relatively undisturbed by human activities and many development opportunities remain that would benefit the region provided that they are developed in a sustainable manner.

Mariculture has been introduced relatively recently to the region, with the exception of the traditional fish farms *(barachois)* of Mauritius. This sector seems to have good potential, as indicated by the success of seaweed culture in Zanzibar, tiger prawns in Mozambique and Seychelles as well as oysters in Kenya.

Although the fish catches are only 40% of levels in the 1970s, most of the national fisheries in the region, are traditional and as such have not succumbed to the massive overcapitalization that is being experienced elsewhere in the world (1).

The region receives an estimated 2 million tourists every year, far less than some countries of the Mediterranean, S.E. Asia, and the Caribbean. However, tourism has declined in some parts of the region, partly due to environmental degradation. The tourism industry is itself one of the causes of environmental damage on the coast. Nevertheless, opportunities do exist for sustainable tourism, with better planning and management (1).

The Western Indian Ocean Region is at a cross roads. On the one hand there are pressures on the coastal environment, which are mainly concentrated to so called "hot spots", and on the other hand there are great opportunities for sustainable coastal development. There is need to understand and effectively manage the direct influences of human activities currently impacting on the coastal and marine environments, as well as to determine how different environments respond under specific conservation scenarios. However, effective management cannot be considered in isolation from the large-scale issues/ phenomena that stand to alter the very foundations of the current coastal and marine resource base that people rely on for their sustenance and livelihood. Specifically, issues such as global warming and sea-level rise may potentially alter large-scale ecosystems and dramatically alter the resource base. For example, in light of the recent coral bleaching event in the WIG region, and the possible consequences that degradation and loss of coral reefs may have for coastal geomorphology, hydrodynamics, and the food chain, issues such as global warming and its consequences cannot be ignored.

Complex decision-making processes that are required for the effective management of coastal and marine environments are generally weakened by inadequate information and research. It is, therefore, essential that appropriate environmental information is available for impact assessments of existing and planned activities, and that a sound scientific base exists which can accommodate the changing needs of environmental management institutions as well as society at large. More importantly, it is essential, that society is provided with a sound platform of expertise and information upon which wise policies and practices in resource management are built. Consequently, input from the scientific community needs to be developed in collaboration with the relevant stakeholders.

BACKGROUND

Since the late 1960s, attempts have been made, through donor assistance, to build capacity within the countries of the Western Indian Ocean, to manage coastal and marine environments. During the 1970s, the first marine scientists in the region were completing their postgraduate studies. They were initially few in number and mainly biologists, concentrating on baseline descriptive ecological studies of various biotopes and investigations of economically important species (2). Crosssectoral, applied research on the issues relating to development and management of coastal areas in East Africa was rare, be cause the capacity was not yet in place. Unfortunately these early efforts did not produce tangible evidence of improved capacity in local institutions to manage coastal and marine environmental issues (3).

In 1989, Sida initiated a regional marine science program in East Africa the aim being to strengthen the capacity to carry out research concerning the sustainable use and management of coastal and marine resources.

The outline of the program was influenced by there commendations from a regional workshop held in Dar es Salaam, Tanzania, November 1989. The workshop was hosted by the University of Dar es Salaam and funded by what was then the Swedish Agency for Research Cooperation (SAREC). From the workshop it was concluded that the program should focus on supporting basic capacity building, as the countries in the region had only limited capacity to generate data and information about the environment and the state of natural resources. Furthermore, the program should support awareness building at the decision-making level, be

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cause policy makers were mostly unaware about the relationship between human activities and the loss of environmental resources in the coastal zone. It was also emphasized that research should focus on issues of relevance to development and sustainable use of natural resources.

During the program the strengthening of the research capacity was achieved mainly through thesis research according to the "sandwich model"; i.e. students conducted all their fieldwork in their home countries and had supervision from their national universities as well as from a supporting university in Sweden. Students would only come to Sweden for course and laboratory work and to present their theses. This approach had many advantages because students worked on locally pertinent projects in which the training process developed both local capacity as well as the knowledge base available for local coastal management activities. This was quite revolutionary for the WIO region where for many years students were sent abroad and had difficulties in translating foreign knowledge to local problems. In these earlier programs many students also chose not to return to their home countries after graduating, which contributed to a "brain drain" in the region.

In addition to individual capacity build ing, research facilities at the participating institutions in East Africa were also improved. This support provided a physical framework for the research conducted by students as well as their supervisors. It also provided improved logistic backup for Swedish students and researchers coming to the region to collaborate with East African colleagues (4).

A number of different activities were supported to increase the awareness about natural resources in coastal areas among different stakeholders in the region. For example, 2 major ministerial meetings were organized, one in Arusha in 1993 and a second in the Seychelles in 1996. The first meeting resulted in the *Arusha Resolution on Integrated Coastal Management in Eastern Africa and the Western Indian Ocean Islands.* This represented a success case of concerned scientists in East Africa convincing top-level policy makers in the respective countries (Madagascar, Mauritius, Mozambique, Kenya and Tanzania) to commit themselves to action to addressing integrated coastal zone management issues (2). The meeting in the Seychelles resulted in the *Seychelles Statement on Integrated Coastal Zone .!V...magement* which was signed by all countries in the region (5). In order to assist East African countries to implement the recommendations from these meetings and to better coordinate coastal management activities, a secretariat (Secretariat for Eastern African Coastal Area Management, SEACAM) was established at the invitation of the Government of Mozambique in Maputo in 1997 (6).

MARINE SCIENCE FOR SUSTAINABLE MANAGEMENT OF COASTAL RESOURCES

The Sida funded Marine Science Program was evaluated in 1999 and it was concluded that it had been very effective in strengthening research capacity and in enhancing regional cooperation and networking (4). Within 10 years, the number of marine scientists with MSc and PhD degrees had increased significantly. Furthermore, the program had had a significant impact in promoting dialogue between policy makers, the scientific community, stakeholders, and NGOs as well as creating public awareness of marine science and coastal resource management.

With this as a background, it became clear that the future challenge for support to marine science in East Africa was to utilize the trained capacity in an appropriate and innovative way to address the coastal problems and to maximize the sustainability of coastal and marine resources. There were now possibilities for multidisciplinary and cross-sectoral coastal and marine research to meet the requirements of integrated coastal zone management activities (ICZM). Sound knowledge of coastal ecosystems and the dependence of people on these natural systems is a foundation for successful ICZM projects (3). However, as stated by Moffat et al. (3), scientific research results seldom feed directly into ICZM projects. The academic culture of "publish or perish" provides no incentives for scientists to communicate beyond the scientific community and research results are often communicated in a format that is difficult to comprehend for ICZM planning purposes. In addition, research tends to focus on research goals that have different time and spatial scales than what is required for answering management questions. As a consequence, ICZM projects based on a foundation of thorough research are rare in the WIO region (3).

To bridge the gaps between academic driven research and objectives of ICZM projects, Sida found it appropriate to focus it's support on 3 different levels; local, national, and regional, with a slightly different emphasis on each level.

The experience from Sida's Marine Science Program was that a regional focus is necessary to encourage cooperation and networking between researchers from different countries, while individual capacity building, in the form of post graduate training, often is done most efficiently on the national level at existing universities, mainly through Sida's bilateral programs. The experiences gained from lCZM projects over the hist 10 years in East Africa indicate that projects directly targeted at the local level with activities planned and carried. out in cooperation with local stakeholders have a relatively high degree of success (3). The programs presented below are closely interrelated, particularly in Tanzania, and it is expected that their combined impact will produce significant advances towards the goal of a diversified capacity in the marine sciences that can contribute towards advances in effective management of coastal and marine resources in the WIO region.

Kinondoni Integrated Coastal Area Management Programme (KICAMP)

On the local level Sida initiated support for the *Kinondoni Integrated Coastal Area Management Programme,* KICAMP in 2000. KICAMP focuses on improving the understanding, management, and utilization of marine and coastal resources in the Kinondoni Municipal Commission, situated directly north of Dar es Salaam. The aim of the program is to formulate a comprehensive plan focused on the use of land and water resources in the area. Four interventions or components with corresponding activities and expected outputs, have been selected as priorities:

- Improved coastal land and water-use
- planning.
- Coastal community development.
- Scientific research through coastal surveys, assessments, and monitoring projects.
- Education, information, and communication.

The program is implemented in close collaboration ,with local stakeholders as well as scientists from the University of Dar es Salaam to ensure that management decisions and land-use plans are based on a scientific understanding of natural and human resources.

KICAMP also serves as an example of Swedish development cooperation within integrated coastal management as set out by the policy guidelines formulated by the Sida Marine and Coastal Zone Initiative. Emphasis is on the coordination of science and management, which is achieved through joint input by the Departments for Research Co-operation, SAREC; Natural Resources and the Environment, NATUR; and Infrastructure and Economic Development, INEC at Sida.

Bilateral Marine Science Programs

On the national level, Sida continues to support capacity building through the bilateral marine science programs at the University of Dar es Salaam in Tanzania (UDSM) and at Eduardo Mondlane Uni

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versity in Mozambique. At UDSM the support aims to improve and increase research capacity in fields related to coastal and marine management in Tanzania. Research activities are encouraged to be linked to local coastal management activities in Tanzania, such as the Kinondoni Integrated Coastal Area Management Programme, Mafia Island Marine Park (MIMP), and the Tanga Coastal Zone Conservation and Development program. By linking the research activities more closely to ongoing development and management programs it is envisaged that scientific information will be provided more directly to stakeholders, whilst the goal of increasing research capacity is maintained. Integration between disciplines is achieved through focusing on applied research rather than on basic research.

The program contains a number of different capacity building activities such as research and postgraduate training, staff and student exchange between Tanzania and Sweden, information dissemination through workshops and publications, procurement of books, journals, laboratory and field equipment, rehabilitation and maintenance of research infrastructure. The priority research themes include fish farming, seaweed cultivation, fish ecology, coral reef ecology, disturbance effects on coral reefs, nutrient dynamics, primary productivity studies, pollution studies and research on habitat restoration and conservation.

At the Faculty of Biology at Eduardo Mondlane University, Mozambique, priority is given to the basic marine sciences in order to increase the academic qualifications of the teaching staff. This support has made a very important contribution to improving research capability in marine sciences and will probably play an important role for coastal management in Mozambique in the future. The scale of effort in coastal management is rapidly increasing in Mozambique, as is the parallel need for scientific input.

Research areas include ecology of marine species, such as marine shrimp, inter tidal crabs and dolphins, and studies of marine ecosystems, such as mangrove forests, swamps and sea grass-beds. Most of the research is being conducted with equipment at the Inhaca Marine Research Station. This station was refurbished and reactivated during the first marine program and is still an important component in Sida' s support to marine research in Mozambique.

Institute of Marine Science

A notable achievement of the bilateral marine program is the transformation of the Tanzania Institute of Marine Science (IMS) of the University of Dar es Salaam into an internationally recognized institution with a permanent staff of 17 researchers of which 10 have PhDs. IMS is attracting funds from a diversity of sources, hosts visiting scholars from many nations and is making significant contributions to public policy and resource management in Zanzibar, Tanzania and the region (4).

Marine Science for Management Programme (MASMA)

On the regional level Sida is currently providing support to a new regional marine initiative in East Africa, the Marine Science for Management (MASMA) program, which is coordinated by the Western Indian Ocean Marine Science Association (WIOMSA) and the Coastal Management Research Centre (COMREC) of the University College of South Stockholm (1).

Since its inception in 1993 WIOMSA has been firmly established as a regional vehicle for fostering scientific and management-related discussion associated with coastal and marine resources (7). Given its solid base of support by scientists and other groups within and outside the region, it seemed appropriate that WIOMSA be strengthened to undertake a more defined role as a regional focal and coordination organization. This idea mirrors the implicit goals of the previous regional program phases of developing and enhancing regional scientific and management capacity to ensure long-term sustainability of the capacity that has been developed to date. Also, it falls in line with Sida's general goal of maximizing regional participation and ownership of the processes.

The MASMA program seeks to contribute to the knowledge and understanding of coastal and marine environment of the region, to raise awareness of coastal and marine issues, to conduct and coordinate research activities of national and regional importance, and to disseminate information and data for sustainable use of coastal and marine resources.

The goal is to improve the contribution of coastal and marine resources to food security, poverty alleviation, and environmental sustainability. More specifically, research results shall provide means for increasing food production, sustaining coastal and marine environment and their diverse biological resources, and enhancing livelihoods and the well-being of the poor people who are dependent on coastal and marine resources. For these purposes, the priority research themes encompass subjects such as sustainable fisheries, food security, and ecosystem research. For the successful management of coastal and marine resources, complementary research focuses on pollution 'hot spots', sustainable tourism, and predictive sciences.

Within each theme, strong links to priority societal and environmental issues are encouraged. For example, sustainable livelihoods and gender considerations are important and relevant societal issues in coastal areas as well as indigenous knowledge systems and conflicts in natural resource use. It is therefore important that the natural as well as social sciences are represented in the different research projects.

The MASMA program also provides a framework for strengthening of research capacity building and postgraduate training as well as enhancement of the institutional capacities of the participating institutions and organizations. Research funds, aimed towards better management and understanding of marine and coastal resources in the region, are set up to allow already established researchers to conduct independent research in collaboration with colleagues from neighboring countries. In light of this it is important that postgraduate training continues to be provided on the national level through Sida's bilateral program. The combination of bilateral and regional programs provides opportunities for scientists to remain at their universities and to continue relevant research.

Since 2000, WIOMSA has been acting as a "Resource Centre" for the Conven

The projects currently funded by MASMA:

-Sustainable Management and Valuation of Seagrass Ecosystems in the Western Indian Ocean Region - Tanzania, Kenya, Mozambique and Mauritius.
-Development of Integrated Pond Culture of Finfish, Shell fish and Seaweed in Zanzibar.
-Incentives for Sustainable Use of Coral Reefs Comparing Open and Limited Access: The Case of the Great Reef of Toliara, Madagascar and the Moheli Coral Reef, Comoros.
-Ecological Economics of Mangrove-Associated Fisheries - Food Security and Sustainability - Mozambique and Kenya.

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tion for the Protection, Management and Development of the Marine and Coastal Environment of the Eastern African Region (Nairobi Convention). Through a Memorandum of Understanding between WIOMSA and UNEP, as the Secretariat to the Nairobi Convention, WIOMSA has been providing research, technical, managerial and advisory support to the Secretariat of the Nairobi Convention as requested. In accordance with this agreement, WIOMSA was fully involved in the planning and implementation of the Third Meeting of the Contracting Parties to the Nairobi Convention held in Maputo in December 200 I, as well as preparing the biennial work program (2002-2003) for the Convention.

WIOMSA's attainment of such recognition is an indication of the fact that the strengthening of WIOMSA through support from Sida serves a wide regional and international interest.

Coral Reef Degradation in the Indian Ocean (CORDIO) Programme

In parallel to the MASMA program Sida also support the CORDIa (Coral Reef Degradation in the Indian Ocean) Programme. CORDIa was initiated early in 1999 and is a regional program developed to investigate the ecological and economic consequences of the mass bleaching of corals during 1998 and subsequent degradation of coral reefs in the Indian Ocean. In addition to researchers from most countries of the WIO region, researchers from Maldives, India, Sri Lanka, and Chagos participate in the program. CORDO, thus, constitutes a network of researchers that facilitates cross-border research within the whole Indian Ocean region which enables the development and implementation of a region wide multidisciplinary research program.

Priority areas for research are *i)* biophysical impacts of the bleaching and mortality of corals and long-term prospects for recovery; *ii)* socioeconomic impacts of the coral mortality and options for mitigating these through management and development of alternative livelihoods for peoples dependent on coral reefs; *iii)* prospects for restoration and rehabilitation of reefs to accelerate their ecological and economic recovery. A number of projects are being conducted under these themes by MSc and Pill candidates from the participating countries ensuring that the necessary training to recognize and deal with problems specific to their own countries is provided.

In addition to specific projects, CORDIO has established long-term regional monitoring programs to assess the status of coral reefs in the central and western Indian Ocean. Through these activities CORDIO has forged strong link with the International Coral Reef Initiative, ICRI (which also is supported by Sida) and with the Global Coral Reef Monitoring Network, GCRMN, in its capacity as an East African Node of GCRMN.

The CORDIO program is an example of regional capacity building activity that has managed to create local capabilities to monitor a key ecosystem to provide early warning in case of abnormal events. The program brings together coral reef experts in the whole Indian Ocean, which was a prerequisite for assessing the regional extent of the mass bleaching of corals during 1998 in the Indian Ocean.

WHAT ARE WE LEARNING?

From experience gained so far a number lessons have been learned. These are summarized below.

Sustaining the support over a long enough period. Research is expensive and institutional and human capacity building is a long-term process. It is not possible to develop competence in all relevant fields needed in a specific institution at once. Long-term support provided by Sida to the WIO region has been instrumental in building both technical and institutional capacity for marine science in the region.

Broad-based support for programs at different levels of governance as well as phases of information generation and utilization. Support by Sida to the WIO region has been broad-based in vision and activities implemented. Support has been provided for activities implemented at 3 different levels namely: local (KICAMP), national (University of Dar es Salaam and Eduardo Mondlane University), and regional (MASMA and CORDIO). The support provided has been in different forms such as research capacity building; information sharing/networking and awareness building, which have helped in linking science to management.

Postgraduate training through the sandwich programme. The region like other developing countries has some unique problems, which require local experts and appropriate strategies and technologies to solve. Since local scientists are conversant with the prevailing situation their research is likely to focus on local problems/issues and lead to sustainable solution.

Supporting institutions programmes rather than individuals' projects. For the purpose of ensuring sustainability, Sida support to the region has been to institution-based programs rather than to specific individuals. Through Sida-funded projects institutions such as the Institute of Marine Sciences, SEACAM and WIOMSA have had their competence improved in several aspects including coordination of regional/international programs, proposal writing skills and fund-raising

Collaboration based on equal partnership. This has been challenging, but significant progress has been made from the days when most of the major decisions were made by collaborating scientists from Sweden. The current situation means that most of the decisions are made jointly through a very transparent and consultative processes.

Monitoring and evaluation of the funded projects. Through regular monitoring and evaluation of the funded projects, accountability has been enhanced and problems addressed in a timely way.

DISCUSSION

When Sida initiated a Regional Marine Science Programme in East Africa in 1989, there were very few marine scientists in the region, the majority being fisheries biologists. Thirteen years later, there is now a core group of scientists and experts in research institutions in most of the countries of the region, these are helping to provide information about the environmental situation of coastal ecosystem and resources. Programs are in place to assess the state of fisheries, coral reefs, and mangroves in the region. Institutions working with coastal zone management issues are in many respects more efficient, have more resources and more academically qualified staff. The accomplishment of this regional program has drawn a number of other donors into the region and there is now a growing number of initiatives at the regional, national, and local levels working to promote effective management of coastal resources as human activities intensify. At the local level, projects like KICAMP have actively engaged a number of communities in management of coastal resources. At the national and regional level, the regional program catalyzed high-level political commitments to integrated coastal zone management and promoted a much needed dialogue between policy-makers and the scientific community.

Thus, capacities for multidisciplinary research to support ecologically sound management of coastal resources are in place, and the major challenge is now to find ways in which these capacities can help to provide new methods for sustainable management of coastal resources. There is an urgent need for the countries of the region to take advantage of the growing capacity in research to enhance integrated management and protection of the coastal resources.

To further strengthen research capacities in marine science and to make the links between research and community development more clear Sida started to

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support a number of different activities in 2000. Through *KlCAMP,* for example, local stakeholders are encouraged to take part in research projects and to utilize research results in support of coastal zone management activities. Researchers, in turn, are encouraged to use local and indigenous knowledge to formulate adequate research projects for the long-term preservation and management of coastal ecosystems.

Capacity building in marine science is provided through Sida's support to national universities. This helps to ensure a self-sustaining scientific capability for sound environmental and natural resource management. It also provides support to other disciplines, such as social sciences, economics, and engineering, which also need to be included in coastal zone management projects.

On the regional level, the MASMA and CORDIO programs have encouraged collaboration between institutions and researchers from different countries, in terms of development of joint research activities and capacity building initiatives. Regional research teams have received funding for a number of multidisciplinary research projects on aquaculture, mangrove forests, coral reefs and sea-grass beds. This form of funding provides an opportunity for established researchers to conduct independent research in collaboration with colleagues from neighboring countries and from Sweden. The programs have also improved the regional exchange of research results. It was through reports from regional networks of marine research institutions and experts in Seychelles, Kenya, Tanzania, and Sri Lanka, most of which had been supported for a number of years through the Sida-funded Marine Science Programme, that the magnitude of the bleaching of coral reefs in the Indian Ocean was first determined (8-11).

However, much remains to be done and new challenges constantly appear on the horizon. On the local level the biggest challenge today is to ensure future funding for ongoing programs such as KICAMP and to keep the involved local communities committed to the goals of the program. On a national level the challenge is to promote the importance of a vital and critical research community to the national governments as well as to the donor community to ensure continuous financial and political support. Priority coastal management issues and the goals and strategies for addressing them should be developed through a consultation process involving governmental agencies, the research community, and leaders of ongoing ICZM initiatives. Links to priority resource management questions should be strengthened through multidisciplinary research structured to address urgent societal and resource management issues. At the regional level emphasis is to promote better collaboration between countries as well as between natural and social sciences. A challenge also lies in improving skills in proposal and report writing and in providing support to local and national research teams to manage their research programs and to match their activity level to available financial and infrastructural resources. Existing capacities should also be used to strengthen new regional research initiatives. Experience gained from the Sida-funded Marine Science Programme in the WIO region could, for example be used in Sida's Lake Victoria Initiative. Furthermore, programs like CORDIO show that there is a large potential for increased South-South cooperation between marine scientists from the whole Indian Ocean Region.

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