Establishing a basis for ecosystem management in the western Indian Ocean

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An ambitious multinational programme, with generous funding for an initial five years, aims to provide understanding of marine resources for the benefit of impoverished island and coastal populations in a much-neglected ocean region.

On 3 October 2008, the Norwegian research vessel *Dr. Fridtjof Nansen* was received in the harbour of the capital of Mauritius, Port Louis, with tumultuous applause, pomp and ceremony. Local dignitaries, ambassadors, official representatives of nine countries of the western Indian Ocean, a host of marine scientists as well as representatives of the media were on hand to welcome the vessel—an uncommonly enthusiastic reception for a seemingly innocuous port stop-over. However, this was in many respects an historic occasion that fully merited such attention. The reasons are the following.

The western Indian Ocean is one of the least explored and least understood of all ocean regions, particularly the South-West Indian Ocean.[1,2] This can be attributed directly to the distance from the most important centres of marine research in Europe and the U.S. The dearth of hydrographic data on this part of the world was pointed out as long ago as 1977.[3]

Subsequently, international interest in the area has grown and recent oceanographic cruises[4] have produced seminal results. In this way it was discovered that the supposedly well-established Mozambique Current does not in fact exist[5] but that instead the Mozambique Channel is populated by a train of eddies slowly moving southward. To the east of Madagascar a totally new current, the South Indian Ocean Countercurrent, has recently been discovered.[6]

There are very few comparable regions where such fundamental discoveries can still be made with such ease. And this holds true not only for physical oceanography, but for all aspects of the marine ecosystem. Species distribution, biodiversity, fisheries potential: all these have remained virtually unknown. The potential for new scientific discoveries may be exciting for oceanographers; but for those responsible for managing the marine ecosystems of each country in the region this ignorance is a serious obstacle. When it comes to ecosystems that cross political boundaries, this ignorance becomes a nightmare. This is where the Large Marine Ecosystem (LME) projects of the Global Environment Facility (GEF) play a role and starts to explain the presence of the Norwegian research vessel in Port Louis (Fig. 1).

The ASCLME project

Since the early 1990s, the poorer coastal nations have approached the GEF (www.gefweb.org) for assistance in restoring and protecting their marine ecosystems. To provide pragmatic support to these countries, the GEF has adopted the LME approach, which encourages a more effective management of marine resources at the complete ecosystem level, across and beyond individual national jurisdictions.

Large Marine Ecosystems are regions of the ocean encompassing coastal areas from river basins and estuaries to the seaward boundaries of continental shelves and the outer margins of the main current systems. They are relatively large in extent (200 000 km^2 or more), characterized by distinct bathymetry, hydrography, productivity, and trophically dependent populations. Globally, 64 LMEs have been identified, which produce 95% of the world's annual yields of marine fishery biomass. Information on 33 of these ecosystems is available at www.lme.noaa.gov.

Implementation of the LME concept through a GEF-funded project requires the creation of a TDA (Transboundary Diagnostic Analysis), focusing on the ecosystem approach, and the negotiation and adoption of an SAP (Strategic Action Programme) that includes management practices which take into account improvements in knowledge as well as changes in socio-economic needs and interests. A TDA aims to scale the relative importance of causes of transboundary problems and opportunities. In addition it identifies potential preventive and remedial actions as sustainable development strategies. An SAP, on the other hand, is a workable framework and unambiguous statement of common goals and the means for their achievement. It adopts negotiated policy, legal and institutional reforms and identifies investment opportunities to address the priority issues identified by the TDA. It also defines a time frame for concrete actions and for implementation at regional and national level along with a mechanism for monitoring success in delivering SAP objectives.

The ASCLME (Agulhas and Somali Current Large Marine Ecosystem) programme is such an LME endeavour.

Fig. 1. The Norwegian research vessel *Dr. Fridtjof Nansen* that is playing a central role in the study of the western Indian Ocean in support of the ASCLME programme.

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Figure 2 indicates the operational area of the programme. It consists of three partner projects. One that addresses land-based activities in the western Indian Ocean (WIOLaB) is being implemented through the United Nations Environment Programme and deals with pollution and coastal degradation among other things. The South-West Indian Ocean Fisheries Project (SWIOFP) is in turn being implemented by the World Bank and primarily addresses offshore commercial fisheries. Thirdly, the ASCLME project itself is implemented by the United Nations Development Programme and focuses on building and collating information on oceanographic aspects, coastal livelihoods, persistent organic pollutants, fish spawning and nursery areas.

South Africa is making a major contribution to the ASCLME, through the second phase of the African Coelacanth Ecosystem Programme (ACEP) that is funded by the Department of Science and Technology and by the Department of Environmental Affairs and Tourism. ACEP will be planning, funding and conducting research on various components of the Agulhas Current. As a contribution in kind, the South African Institute for Aquatic Biodiversity (SAIAB) hosts the ASCLME management team in Grahamstown.

The ASCLME project currently has nine participating countries (Comoros, Kenya, Madagascar, Mauritius, Mozambique, Seychelles, South Africa, Tanzania and Somalia, where politics allows). It is being funded by the GEF to the tune of US$12.2 million, with a further US$20 million promised in co-funding by the participating countries and other international partner agencies. The time frame for this project is five years to mid-2012. Alongside the aims described above, there is a strong focus on capacity building within national and regional institutions, training of individuals to fill gaps in scientific skills, adoption of long-term monitoring programmes at both national and regional level, and the development of effective data management within the region. More about this below.

One of the most visible components of the ASCLME project will be its scientific investigations based on research cruises throughout the western Indian Ocean. These are aimed at filling the most crucial knowledge gaps, particularly in relation to the effects of ocean currents on the productivity and natural resource sustainability within the LME.

Cruises undertaken and planned

Four research cruises were organized by the ASCLME project in 2008 (Fig. 3): an East Madagascar Current cruise (43 days),

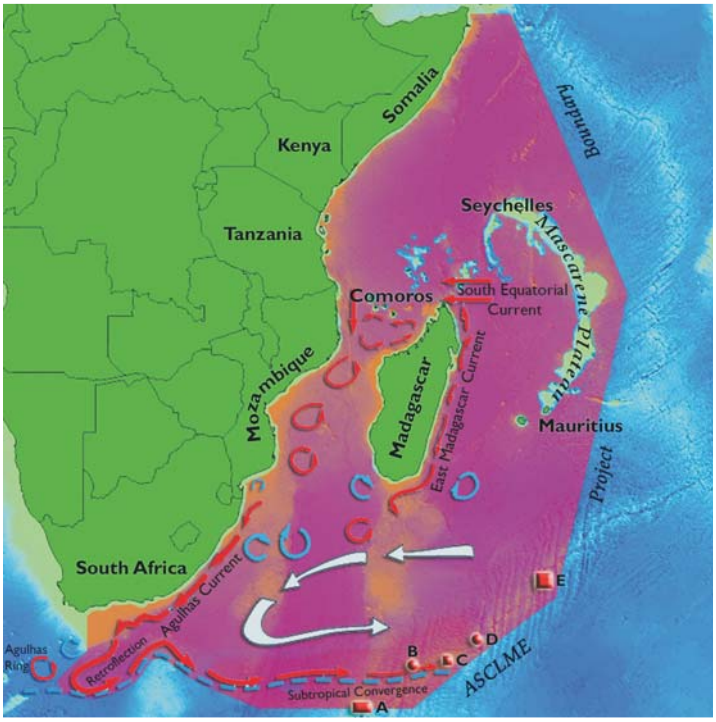

Fig. 2. Map of the western Indian Ocean with the ASCLME project area in purple. The red and blue arrows show distinguishing currents of the recently surveyed Agulhas Current system; red circles anti-cyclonic eddies, blue circles cyclonic eddies and white arrows large-scale motion (after Ansorge and Lutjeharms[11]). The broken line portrays the southern frontal boundary to the region. A–E show a series of seamounts on the South-West Indian Ridge that forms part of the southern boundary of the ASCLME region.

a cruise to study the Mauritian deep-sea environment as an island ecosystem (4 days), a baseline survey of the Mascarene Plateau (41 days), and a study of the role of dipole eddies in the Mozambique Channel ecosystem (20 days) that is co-funded by ACEP.

All the cruises were conducted on board the *Dr. Fridtjof Nansen* with scientists participating from South Africa, Madagascar, Mauritius, Seychelles, Mozambique, Norway, the United States and France. The objective of the research cruises was to carry out a full multidisciplinary survey, concentrating on those regions conceivably most important for the management of the resources and the ecosystems of the western Indian Ocean.

A partnership has also been forged between the ASCLME and NOAA (the US National Oceanic and Atmospheric Administration), whereby the latter provides ATLAS moorings (Fig. 4) and Argo floats; the ASCLME provides ship's time

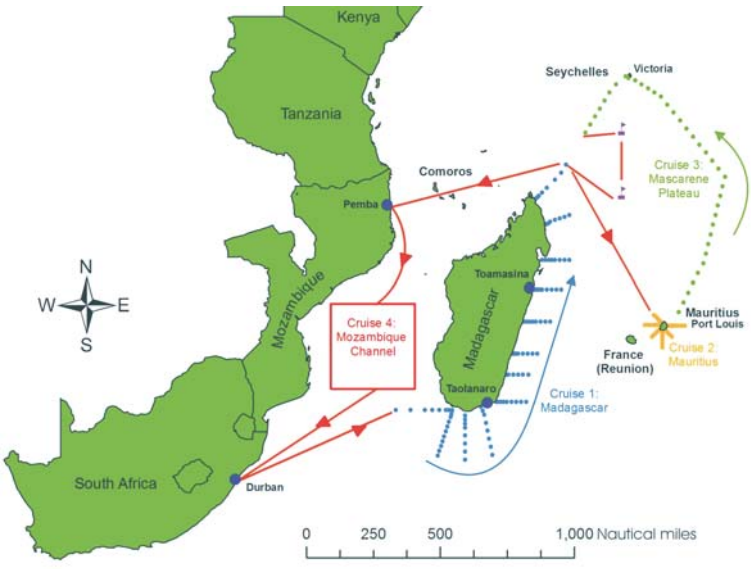

Fig. 3. Cruises undertaken as part of the ASCLME during 2008. Dots denote full hydrographic stations and flags denote ATLAS moorings northeast of Madagascar. In addition, a mooring was placed off Pemba on the coast of Mozambique. No station positions are given for Cruise 4, as this is a flexible cruise totally dependent on the location of eddies in the Mozambique Channel at the time.

Fig. 4. An ATLAS deep-sea buoy being moored during an ASCLME cruise in 2008. This buoy boasts a large number of meteorological and oceanographic sensors, the readings of which are transmitted in real time.

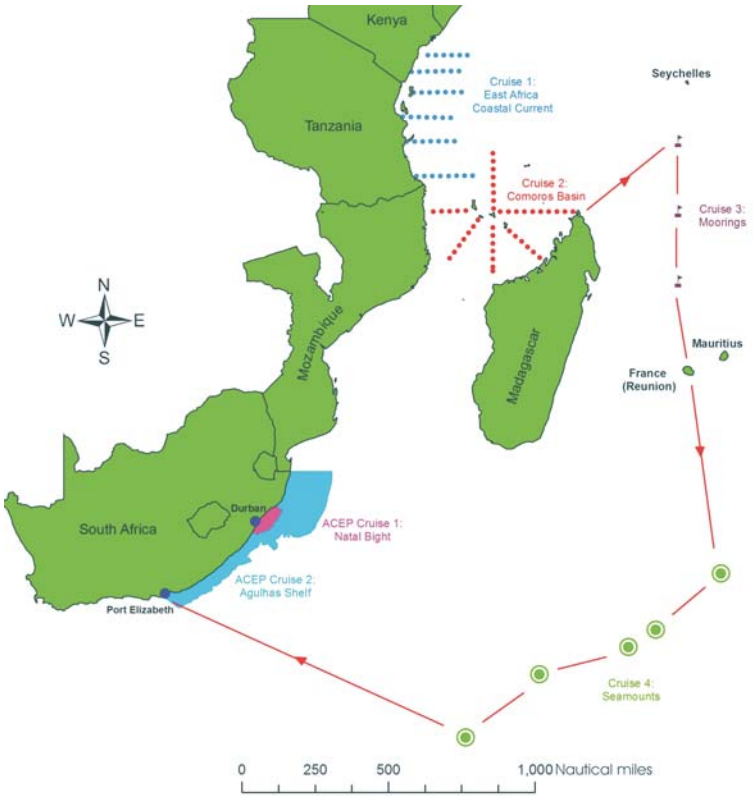

Fig. 5. ASCLME cruises planned for 2009 in the western Indian Ocean. The cruise in the Comoros Basin is aimed at studying the Comoros Gyre as well as the distribution of coral larvae there. On the way to Réunion, an extra ATLAS mooring is to be deployed. Two cruises on the east coast of South Africa as part of ACEP will investigate the Natal Bight (cyan) and the continental shelf inshore of the Agulhas Current (blue).

for deploying the instruments along a section of the RAMA (Research Moored Array for African–Asian–Australian Monsoon Analysis and Prediction) observational network.[7] ASCLME is committed to servicing these moorings for the duration of the project; they are of inestimable value as they provide real-time and continuous data on a variety of oceanographic and meteorological factors in an ocean region that otherwise is difficult to access.

Several research cruises are planned for 2009, following recommendations from the nine partner countries (Fig. 5): an East Africa Current cruise (25 days joint cruise with SWIOFP), a cruise in the Comoros Gyre in the northern part of the Mozambique Channel (25 days), mooring deployment and service (15 days), and a cruise to study seamounts and the Agulhas Return Current (41 days). The objective of the last cruise is to apply an ecosystem-based approach to fisheries management for biologically significant and commercially important areas beyond national jurisdiction. In South African waters two regions stand out as being of special ecosystem significance: the Natal Bight north of Durban and the inshore edge of the Agulhas Current on the continental shelf. During 2009, two specially designed cruises of the ACEP will be carried out on the fisheries research ship *Algoa* to study these systems (see Fig. 5).

To achieve all these lofty aims, local marine scientists and decision makers need to acquire appropriate skills to absorb and interpret the new information the cruises will generate. This is particularly important because so many people in the region are dependent on the adjacent ocean for their livelihood.

Capacity building

Over 160 million people reside in countries bordering the ASCLME; the coastal population is estimated at 55 million. The area has some of the highest poverty levels in the world. Communities in the coastal regions therefore place great reliance on the sea through the harvesting of living marine resources for subsistence as well as from employment in artisanal fisheries, transport and coastal tourism. Fish harvesting, processing and marketing generate livelihoods for approximately 2.2 million people.

Training therefore plays an integral role in the sustainable development of the region and in fulfilment of the objectives of the ASCLME project. Each country has nominated a person responsible for training and a regional coordinator oversees all training activities. At a recent meeting in Mauritius, these country coordinators drew up a template for national training plans, to be used to assist in the development of the National Marine Ecosystem Diagnostic Analyses, the TDA and the SAP.

The collection of oceanographic and fisheries information during ASCLME cruises provides an excellent training opportunity and each country is actively involved in the cruise planning, execution and the subsequent analysis of the data. Furthermore, a first regional training course was offered at the University of Cape Town in 2008. This training course provided an introduction to the basic principles, methods and technologies used in the collection of oceanographic and biological data (www.asclme.org). A similar course is being planned for 2009.

The training course highlighted the difficulties in collecting basic oceanographic data in the region, and the need for suitable equipment. To assist, the ASCLME partners agreed to make a suite of basic oceanographic instruments available to participating countries. This equipment can all be deployed from the many small vessels found in the region. In 2009 each of the receiving countries will be instructed on the use of these instruments and on the collection, housing, analysis and interpretation of data with a view to setting up monitoring programmes that may extend beyond the duration of the ASCLME project.

Data and information management

For ASCLME-funded expeditions to support the ecosystem approach effectively, data collected at sea must be processed and the results then published

after peer review to contribute to knowledge necessary for management advice. In addition to publication, data and specimens must also be described and archived to ensure that they are accessible for the long-term benefit of the region. Substantial amounts of data collected by marine scientists around the world are not archived. This material is often irretrievably lost and so unavailable for studies of, for instance, long-term environmental change.[8]

The process of data documentation and secure long-term archiving for the ASCLME project must therefore be well managed to ensure that the maximum use is made of costly opportunities to participate in ocean-going expeditions. It has been essential to set up mechanisms at the start of the project to ensure this happens.

The ASCLME project has convened a working group of data and information coordinators, one from each of the participating countries, to design and implement management systems that are appropriate for the requirements of these nations. This working group has compiled documents on principles and guidelines for data management.[9] Data archives will be maintained in national institutions of partner countries. Additional support will be provided by the ASCLME to build the capacity of these centres where required. This approach aims to achieve the goal of sustainable national data archives that countries can use in the support of ecosystem management in the long term.

As part of the ASCLME project activities, each country will furthermore produce a Marine Ecosystem Diagnostic Analysis (MEDA) and National Action Plan (NAP), which will be the respective contribution from each country to the regional TDA and SAP. During the first year of the ASCLME project, there have been negotiations with other regional agencies and projects to ensure that ASCLME data and information systems build on those already established by other UN agencies.[10] This is crucial for the long-term, integrated support of transboundary governance.

Governance

As mentioned above, the ultimate objective of the ASCLME programme is to have an agreed SAP for managing the marine and coastal resources for the region based on an ecosystem approach. This will ideally be integrative and adaptive, be specified within a definite geographic region, will take into account ecosystem knowledge as well as uncertainties, will consider multiple external influences and strive to balance diverse social objectives. Several factors will complicate reaching these noble aims.

For instance, based on their history and culture, national ocean management styles vary considerably from one country to another. This diversity of cultures includes African, Indian, Chinese, Arabic, Portuguese, British and French. In addition, several international agreements have already been formulated and these include the Convention on the Protection, Management and Development of the Marine and Coastal Environment of the Eastern African Region (Nairobi Convention); the South Western Indian Ocean Fisheries Convention (SWIOFC); and the Intergovernmental Oceanographic Commission's Regional Committee for the Western Indian Ocean (IOCWIO). Expanded regional agreements such as the Indian Ocean Tuna Commission (IOTC); the Southern African Development Community (SADC); the Coastal and Marine Sub-programme of the African Union's New Economic Partnership for African Development (NEPAD); and the recently negotiated Southern Indian Ocean Fisheries Agreement (SIOFA) under the aegis of the FAO, add an extra complexity.

The countries of the region have also subscribed to several international agreements, notably the United Nations Convention on the Law of the Sea (UNCLOS), the Convention on Biological Diversity, which addresses marine and coastal issues, conventions under the International Maritime Organization (IMO), and the FAO–Fisheries Code of Conduct. All these policy and management instruments bring in a diversity of governance mechanism which are sectoral and, if not harmonized, may lead to a polarization of effort that results in unsustainable management of marine and coastal resources.

An additional layer of impediments to the governance of the western Indian Ocean is the way that the boundaries of large marine ecosystems have been defined to match the areas of the exclusive economic zones (EEZ) of the countries involved. This leaves areas of the ocean outside the EEZs without effective governance and open to abuse. A classic case in this regard is that of the destruction of the rock lobster resource on the Vema Seamount[12,13] that lies outside any national jurisdiction.

There is therefore no single existing mechanism that currently lends itself to regional governance of the ASCLME region. Clearly there is need to integrate legal instruments as well as the various marine and coastal projects in the region in order to bring about the desired ecosystem approach to governance. The ASCLME will therefore need to address both the regional management areas within national jurisdiction as well as the regions beyond national jurisdictions.

Conclusion

The past two decades have seen several large international research efforts in the western Indian Ocean.[14,15] These were, however, almost exclusively aimed at understanding the processes responsible for the climatologically important[16] exchanges of water between the Indian and the Atlantic oceans. None of them was widely multidisciplinary and none was aimed at addressing directly the marine management needs of the countries of the region. The ASCLME programme is therefore a trailblazer in managing cross-boundary marine ecosystems, relying on a solid base of knowledge in this much-neglected ocean region.

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