

# SCIENCE AT SEA IN TANZANIA

FOUNDED 25 YEARS AGO, THE UNIVERSITY OF DAR ES SALAAM'S INSTITUTE OF MARINE SCIENCES IS SLOWLY CARVING OUT AN INTERNATIONAL REPUTATION FOR ITSELF. IN 2002, IT WAS ONE OF SIX RESEARCH UNITS IN LEAST DEVELOPED COUNTRIES TO BENEFIT FROM THE AWARD OF A TWAS GRANT. AN OUTLINE OF THE INSTITUTE'S DEVELOPMENT AND RESEARCH PROGRAMMES FOLLOWS.

**T**he coastline of mainland Tanzania measures more than 800 kilometres. Three islands lying 25 to 50 kilometres offshore, Unguja and Pemba (which together make up Zanzibar) and Mafia, add 600 kilometres to this total. The idyllic tropical setting, with long, sandy beaches shaded by coconut palms, is enhanced by a fringe of coral reefs, broken only where the rivers that flow across Tanzania's narrow coastal plain spill into the sea.



mangrove swamps – is to survive increasing pressure from a growing human population.

Some 8 million people now live in Tanzania's 15 to 25 kilometre-wide coastal plain, a population that could rise to 16 million by 2010. These people

will be catching decreasing fish stocks for food, cutting down mangrove forests for fuelwood, mining beach sand for building materials, and farming the limited land available.

Imports and exports from the land-locked countries of Burundi, Malawi, Rwanda and Uganda must also arrive and depart from ports on the Tanzanian coast that is heavily used by oil tankers and other ships.

"There is a serious paucity of data on the ocean topography, coastal dynamics and other physico-chemical conditions of Tanzanian waters," says Alfred Muzuka of Tanzania's Institute of Marine Sciences. "Lack of information on the tides and currents of coastal waters and coastal

Zanzibar itself is an increasingly popular tourist destination, with people flocking to sample the delights of scuba diving among the coral reefs and to savour the flavour – literally – of the island's most famous exports, spices such as cinnamon, cloves and vanilla.

Against this backdrop, there are serious development issues that need to be addressed in an integrated and systematic manner if the patchwork of ecosystems – from sand dunes to seagrass beds and coral reefs to

geology, for instance, has been singled out as a major cause of the failed attempts to replant mangrove trees.”

### RESEARCH REQUIRED

Muzuka is a senior research fellow at the Institute of Marine Sciences (IMS), located on the island of Zanzibar. His research group is one of six that were awarded a TWAS Research Unit in Least Developed Countries grant in 2003. (For details of the others, see *TWAS Newsletter* Vol. 15, No. 4, pp. 9-13). Having put the first instalment of US\$30,000 to good use, TWAS has just approved the award for a second year and allotted another US\$30,000 to the institute.

“Tanzania’s coastal waters are rich in marine resources and important ecosystems,” continues Muzuka. “The relationship between these ecosystems and the productivity of the coastal waters is intrinsically linked to the physics of the coastal waters. It is therefore very important for the IMS to be given the necessary support to study and collect the information needed to understand the dominant physico-chemical processes in these waters.”

Unravelling these processes is a major priority of the IMS. Established in 1979 to strengthen marine science research, the IMS has three major objectives:

- Undertake research in all aspects of marine sciences.
- Provide undergraduate and postgraduate training to boost the nation’s expertise in marine sciences.
- Offer advisory and consultancy services in marine affairs.

Based on these aims, IMS research now plays a major role in helping the country identify and address issues related to the marine environment. The expertise of the

institute’s scientists, many of whom have trained abroad but returned to their home nation, also enables Tanzania to contribute to national, regional and international programmes devoted to the study of the oceans and their resources. Through research, advice and direct intervention, IMS scientists also assist Tanzania’s food security and poverty alleviation programmes.

The institution’s research activities are divided into three sections:

- Living Resources and Ecology, which includes marine botany and fisheries research.
- Chemical and Environmental Marine Sciences, which includes chemical oceanography and marine pollution studies.
- Physical and Applied Marine Sciences, which includes physical oceanography, marine geology and ocean engineering.

Muzuka’s research falls into this last section – the institute’s largest – and it was this group that was awarded the TWAS grant. Specifically, the grant was given for: “The study of environmental changes in Tanzanian coastal waters for the sustainable utilization of marine resources and the conservation of coastal ecosystems,” explains Muzuka.

“The grant enabled us to buy an automatic elemental analyser,” he adds. “Now we can quickly and accurately determine the proportions of such elements as carbon, hydrogen, oxygen, nitrogen and sulphur that play important roles in biological processes in marine and other environments.”



**Alfred Muzuka**

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## PROTECTED ZONES

*The University of Dar es Salaam's Institute of Marine Sciences (IMS) has been instrumental in the establishment of various marine parks and conservation areas. Among these are the Mafia Island Marine Park and Zanzibar's Menai Bay Conservation Area.*

*Mafia Island Marine Park was created in 1995 with assistance from the World Wildlife Fund (WWF), which continues to provide human and financial resources for its development and maintenance. Covering more than 800 square kilometres, the park is composed of mangrove and coastal forests, seagrass beds, coral reefs, intertidal reef flats and a lagoon.*

*These habitats are home to some 400 species of fish and many types of marine invertebrate, making the park one of the richest ecosystems on the east African coast. In addition, Mafia Island is also a nesting area for both green and hawksbill turtles. Since 2001, some 5,000 young turtles have successfully hatched from 200 protected nests. Before the establishment of this park, dynamite fishing and coral mining caused substantial damage to the marine environment. Dynamite fishing has since been outlawed. Fisheries were also being harmed by the use of small-mesh beach-seine nets that removed juvenile fish and damaged coral reef and seagrass habitats. With WWF assistance, these fishing practices are being phased out and management plans are being put in place to help the 18,000 islanders develop more sustainable fishing methods and such alternative sources of income as seaweed farming and tourism. IMS scientists have been directly involved in environmental impact assessments for the building of a park headquarters and a boathouse and boat-launching ramp. IMS officials continue to play an active role in both the Mafia Island Marine Park and the Menai Bay Conservation Area as members of their respective advisory committees.* ■

Before this, whenever IMS scientists required data on such elements, they had to pay for the analysis to be carried out in laboratories abroad.

"This was both costly and took more time for the analyses to be completed," says Muzuka.

"With this year's grant money," continues Muzuka, "we plan to buy an atomic absorption spectrometer. All of this equipment will enhance the research capability and output of the institute."

Understanding the dynamics of marine sediments is important for many reasons. "Sedimentation in harbours and navigational channels is a constant headache, requiring continuous efforts to keep these transportation routes clear," says Muzuka. "In other areas, coastal erosion is a serious problem. Forest clearance on Maziwi Island, for example, greatly accelerated erosion and contributed to the island's eventual disappearance."

In addition, there has been a construction boom in Tanzania since the 1980s, the raw materials for which – sands and gravel – have been extracted from rivers and streams. "This deprives the beaches of the sand and silt they require to maintain their equilibrium," adds Muzuka.

One inter-disciplinary survey has already determined

that coastal communities are aware that some of their activities contribute to the deterioration of local beaches. However, the survey also indicated that the people lack knowledge of how to mitigate these effects. To counter this, the IMS has produced videos and brochures explaining how communities should care for their beaches. The institute is also playing a key role in designing structures to protect against coastal erosion.

In other areas, landmass is increasing due to siltation. Muzuka's colleague in the Physical and Applied Marine Sciences section, Yohana Shagude, for example, has used Landsat satellite images taken in 1986, 1998, 1999 and 2000 to compare the outline of the Ruvu River delta.

The images show that, especially between 1986 and 1998, the landmass increased by about one square kilometre every three years. What is not known is whether this growth occurred gradually, or was the result of the extreme rain that fell – and the landslides it caused – during the 1997-98 El Niño Southern Oscillation event.

Such studies – related to the long-term effects of climate change – are another aspect of the work of the IMS.

"A change in the world's weather pattern will result in variations in the water discharge and sediment supply

to the coastal zone,” explains Muzuka. “One aim of the project for which TWAS provided the grant is to document past and present changes in the intensity and direction of monsoon winds and their impact on the productivity of the coastal waters. We will also try to determine the degree to which each coastal segment is at risk of inundation from storm surges and river flooding, and classify areas of the coastline according to their degree of vulnerability to erosion and flooding.”

With the predicted increase in the human population of coastal Tanzania and the conflicts of interest of various land uses that will likely ensue, such studies will allow the Tanzanian government to decide, for example, which areas are important for water catchment, which areas should not be settled because they are at risk from flooding, and which areas are best suited to agricultural production.

## LIFE SCIENCES

As human population increases, so does the pressure on the area’s flora and fauna. The IMS Living Resources and Ecology Section is mandated to measure these impacts and design ways of reducing or eliminating them.

Critical pressures include the use of destructive fishing gear, pollution from untreated waste and agricultural

run-off, and coral mining – a source of lime and cement for the construction industry.

Apart from assessing the fish catches in the waters around Zanzibar, and tracking population fluctuations of the major commercial species, scientists in the Living Resources and Ecology section have also initiated pilot projects for developing environmentally friendly aquaculture. Fish farming has great potential in Tanzania –

not only as a source of protein for the growing population but as an opportunity for entrepreneurs to make money and provide jobs for local people.

Partners are also being sought to develop *Spirulina* farming. This single-celled blue-green alga, which grows in warm, brackish water, contains

more than 60 percent protein (by comparison, beef contains only 22 percent protein) and many other essential nutrients such as vitamin B<sub>12</sub>. In addition, the photosynthetic efficiency of *Spirulina* is two to three times greater than crops such as soybean.

Another marine-related industry has already proven itself to be environmentally friendly – seaweed cultivation. The practice, which was introduced into Zanzibar in 1989, now accounts for 20 percent of the island’s annual export earnings. Moreover, throughout Tanzania, it provides employment for some 30,000

***IMS aims to classify areas of the coastline according to their degree of vulnerability to erosion and flooding.***



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people. Women, in particular, are involved in planting and harvesting the crops and many are becoming their families' main breadwinners. Tanzania now exports some 5,000 tonnes of dry seaweed each year, mainly for the extraction of carrageenan for the food and pharmaceutical industries.

IMS scientists have been instrumental in introducing seaweed farming into the Lindi and Mtwara areas of southern Tanzania. In addition, they have launched a research project aimed at increasing the genetic base of the cultivated species (*Kappaphycus alvarezii* and *Eucheuma denticulatum*) that will allow the seaweeds to withstand potential environmental changes and diseases. The institute has also put in place monitoring programmes to assess the environmental and economic impacts of seaweed production.

### INTERNATIONAL TIES

Like many institutions in the South, IMS is supported through a combination of government funds and donor contributions. The Swedish International Development Cooperation Agency - Department for Research Cooperation (Sida-SAREC), for example, supports the IMS through a bilat-

eral programme. Some five PhD students come to IMS each year, mainly from Sweden, to carry out fieldwork using the institute's facilities. Likewise, the Canadian International Development Agency (CIDA) has been instrumental in the institution's long-term development. Muzuka himself also has strong links with Canada.

"I received my MSc degree in geochemistry from the Memorial University of Newfoundland and my PhD from the University of Que-



**Alfonse Dubi**

bec at Montreal," he says proudly.

Thanks to this personal link, the Memorial University of Newfoundland has played a key role in supporting the institute's technical and human capacity building and research efforts.

The staff's international outlook has helped enhance the institute's reputation abroad. In a prime example of South-South collaboration, Alfonse Dubi, the institute's director has been invited to teach courses at the University of Mauritius and the University of Namibia. IMS also collabo-

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rates with the School for International Training in Vermont, USA, part of the US-based World Learning organization, providing facilities and expertise for a 15-week summer study course.

Closer to home, IMS scientists helped establish the Western Indian Ocean Marine Science Association (WIOMSA) in 1992. This organization, which is a member of the Third World Network of Scientific Organizations (TWNISO), provides its members with research funds and travel grants to facilitate collaboration among institutions. One of Muzuka's research projects, for example, which is examining the distribution of heavy minerals along the west coasts of Unguja and Pemba Islands, is funded by WIOMSA. The information gathered will help Muzuka work out the geological history of the region and identify potential sources of heavy minerals on the two islands.

IMS is also involved with other regional programmes, particularly the marine-related projects of the Eastern African Action Plan, funded largely by the United Nations Environmental Programme (UNEP). In addition, coral reef research is funded by the World Bank and the Global Environment Facility (GEF), while other programmes are funded by the International Oceanographic Commission (IOC).

## INTEGRATED MANAGEMENT

"The coastal zone of Tanzania is threatened by a combination of anthropogenic and climatic factors, but it also has the potential to provide a vast number of valuable resources. Therefore, proper management, based on good quality scientific data, is vital," says Muzuka. "Thanks to the work of IMS scientists, the importance of coastal zone management is now recognized at the highest political levels. Coastal zone management issues have been identified and projects initiated throughout the region."

These projects – many of which involve the IMS in either research or advisory roles – cover a wide spectrum of issues including not only the marine sciences but also environmental economics and socio-anthropological research on coastal zone resource use. For example, IMS is chairing the Science and Technical Working Group of the Tanzania Coastal Management Partnership (TCMP) focusing on such issues as the management of mangroves and fisheries.



"With its qualified staff and broad expertise, modern facilities and increasingly sophisticated laboratory equipment, and network of collaborating partners in both the North and the South, the IMS is well placed to integrate all this data into meaningful action," claims Muzuka.

Only through such integrated management plans can Tanzania – and other Third World countries – develop and utilize their natural resources in a sustainable manner.

Helping its host nation – and others in the region – in this way, as the IMS is doing, is surely a worthy aim for all scientific research institutes. ■

*For additional information:*

❖ [www.ims.udsm.ac.tz](http://www.ims.udsm.ac.tz)