Africa:
tsunami alerts and rising sea levels

Marine scientists would monitor sea level changes along the entire coastline of the world if we could. This would give us a much better idea of the reasons for different rates of sea level rise from place to place and allow us to reduce uncertainty when providing governments with predictions. The problem is there are major gaps in the global network. Coverage is good around Europe, the Pacific Rim and North America, but there are gaping holes around Africa. Even where tide gauges exist, the equipment is often old. As a result, we have little information on how fast sea level might be rising along African coasts, including near two major population centres: Lagos in Nigeria and Alexandria in Egypt.

In 2004, UNESCO (the United Nations Educational, Scientific and Cultural Organization) asked scientists at Proudman Oceanographic Laboratory (POL) to work with them on upgrading over a dozen new sea level stations in Africa. In December that year activity became more urgent following the Sumatra earthquake. As a result, we extended the project to sites in the north-west Indian Ocean where there are potential tsunami risks from the Makran Subduction Zone, which extends off the coasts of Iran and Pakistan.

Sea level change can be a difficult quantity to measure. The equipment needed depends critically on environmental conditions and the available local infrastructure. For the African sea level system, UNESCO's Intergovernmental Oceanographic Commission (IOC), asked us to advise on equipment and provide installation guidance through its Global Sea Level Observing System (GLOSS) and Ocean Data and Information Network for Africa (OdinAfrica) programmes. It was obvious that any new equipment we installed had to be tsunami enabled. In addition, we needed to provide training programmes so that local people could effectively maintain the equipment.

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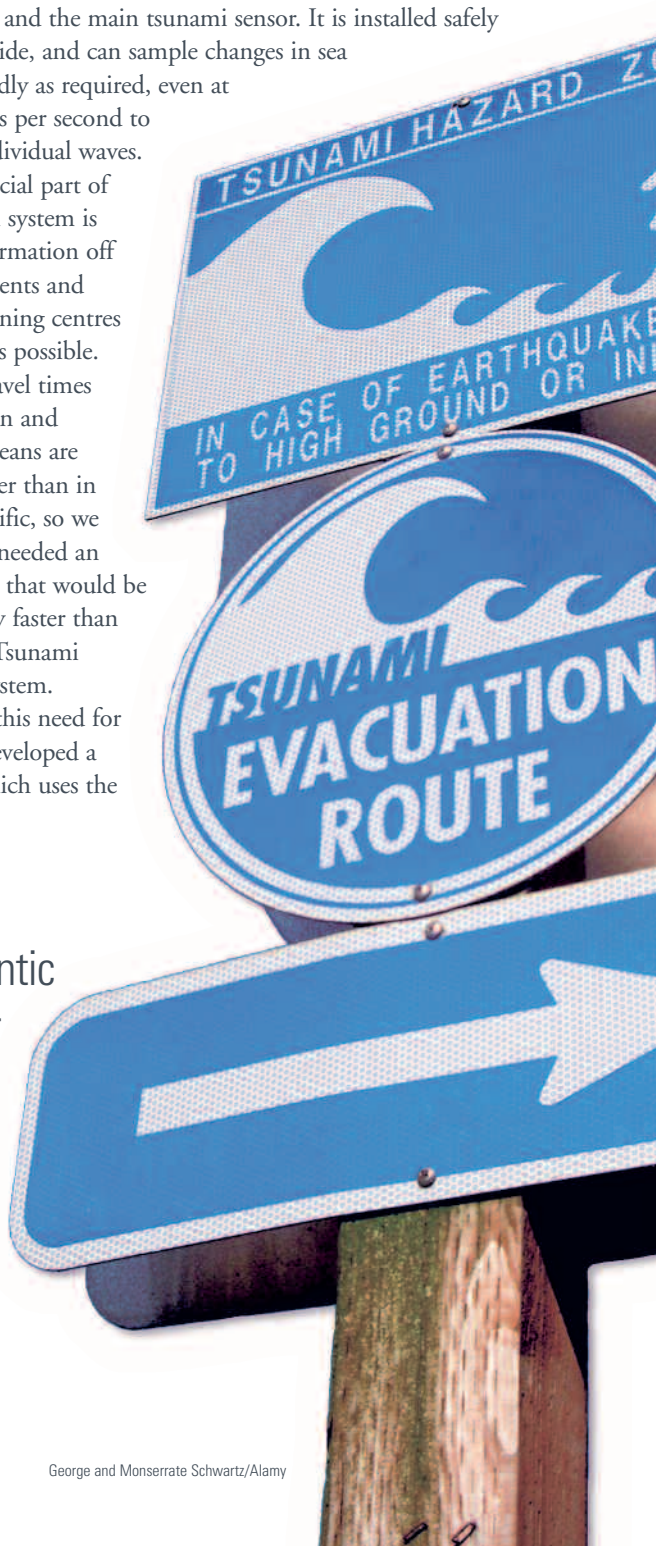
Our first priority was the Indian Ocean, but the Atlantic and Mediterranean are far from risk free. A devastating earthquake and tsunami destroyed Lisbon in 1755 killing over 60,000 people. In the Mediterranean the cataclysmic Santorini tsunami struck Alexandria in 1638BC and smaller tsunamis hit in 363AD and 1303AD. As a consequence, we are involved in a major European Union funded research programme into tsunami risk along European coastlines with special emphasis on Mediterranean coasts.

In Africa we are generally installing two bits of equipment: a radar tide gauge and a sub-surface pressure sensor. We clamp the radar tide gauge to a sturdy beam bolted to a harbour wall. The gauge hangs out over the sea and measures the time it takes for a pulse to reflect back from the sea surface. This provides data for tidal studies and research into sea level changes due to climate change. A sub-surface pressure sensor is both a backup to the radar gauge and the main tsunami sensor. It is installed safely below low tide, and can sample changes in sea level as rapidly as required, even at several times per second to measure individual waves.

The crucial part of the tsunami system is getting information off the instruments and back to warning centres as quickly as possible. Tsunami travel times in the Indian and Atlantic Oceans are much shorter than in the vast Pacific, so we realised we needed an alert system that would be substantially faster than the Pacific Tsunami Warning System. Because of this need for speed we developed a solution which uses the



George and Monserrate Schwartz/Alamy

How fast is sea level rising around Africa? Scientists aren't sure. **Philip Woodworth**, **Simon Holgate**, **Peter Foden** and **Jeff Pugh** explain how they are addressing this and helping to build a tsunami warning system for the Atlantic and Indian Oceans at the same time.

same satellite technology that broadcast journalists use to send back live reports from war zones. The system provides an 'always on' broadband connection almost anywhere on the Earth's surface. In fact the Antarctic marathon was broadcast live using such equipment. POL and IOC have linked up with a European satellite company, INMARSAT, who provide this kind of service, known as the Broadband Global Area Network (BGAN). We use highly portable devices, of similar size to a laptop computer which hook up to the tide gauge electronics and can then link to a satellite and the web. A major advantage is that it does not depend on local telephone or internet connections. IOC now have a deal with INMARSAT to use the system in the Indian Ocean tsunami warning system, and they intend to convert several African and Indian Ocean sites to the BGAN system during 2007-08.

Since the start of the project we have installed equipment across the continent, from Nouakchott in Mauritania on the west coast, to Djibouti and Aden, the cities guarding the entrance to the Red Sea on the east. Working with consultants from IOC and the French and South African Hydrographic Offices, we visit each site before we deliver the equipment to resolve any local difficulties. The first two new sites were Pemba and Inhambane, both in Mozambique in 2005, followed by Takoradi in Ghana, Nouakchott and Karachi in Pakistan in 2006. This year we have already upgraded three existing sites in South Africa, and Djibouti. At the time of writing we are delivering equipment to Aden in Yemen, Pointe Noire in the Congo and Port Sonara in Cameroon, and consultants are travelling to Alexandria and possible sites in Morocco.

Belgian, French, German and US governments are committed to upgrades at other African sea level stations and on islands in the western Indian Ocean. Meanwhile, NERC is committed to maintaining and enhancing the UK network of sea level stations at Gibraltar, Ascension Island, St Helena, the Falklands and Tristan da Cunha, as well as Antarctica through its Oceans2025* funding to POL.

The Indian Ocean warning system became operational in August 2006. As for the rest of Africa, if all goes to plan we expect to see a vast improvement in sea level and tsunami monitoring in the African third of the world within the next two years. ❖

New tsunami early warning stations

A radar tide gauge at a test facility at Gladstone Dock, Liverpool.

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**NERC and seven of the UK's leading marine centres have developed the £120 million 5-year Oceans2025 programme to jointly address key marine science issues. www.oceans2025.org*