Long-term Monitoring and Early Warning Mechanisms for Predicting Ecosystem Variability and Managing Climate Change

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Climate change and marine ecosystem management are intimately linked. The world's oceans play a vital role as part of the planetary life-support system. The oceans support vast commercial living resources that in turn support national economies. They are also important for the maintenance of global biodiversity and represent an essential source of livelihood and food security for many coastal communities that live a subsistence lifestyle. Furthermore, the oceans regulate climate and many of the planet's biological, chemical and physical cycles.

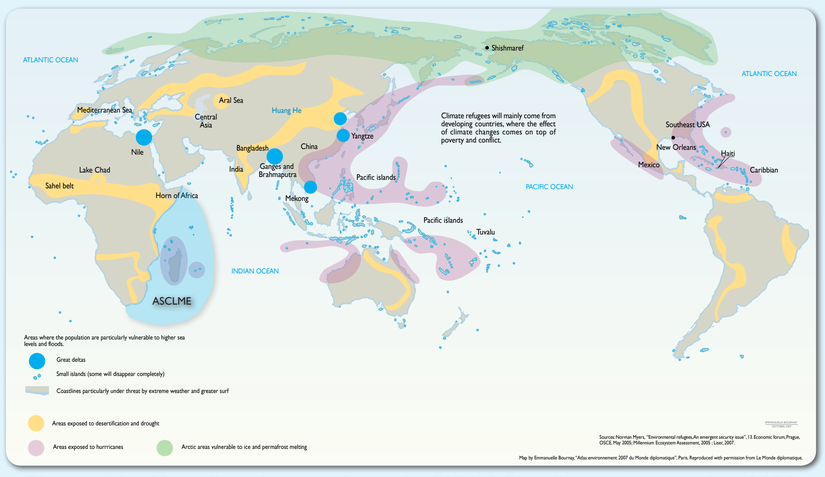
Large Marine Ecosystem (LME) interactions are critical to climatic variability (both in terms of their climatic driving functions, as well as their being impacted by climate variability). Yet research is lacking in many areas linking marine ecosystems and climate change. Monitoring is fragmented and unsustainable thereby preventing scientists and policy-makers from making informed decisions on ecosystem-based management and on adaptive reaction to climate change.

"Changes are inevitable...

Much emphasis has been placed on the need for adaptation to climate change, on developing a framework for action, particularly at the national level and on matching financial and technical support (primarily focusing on technologies for adaptation). Little attention, however, has been given to the need for sustainable monitoring and measurement mechanisms at the regional and local level that can A) provide accurate indications of specific changes related to climate change at the ecosystem level whilst B) identifying the scale and distribution of expected impacts and C) translating these into reliable predictions and policy guidelines which countries can act upon so as to adapt and mitigate/avert the negative impacts.

...and we need to prepare for them."

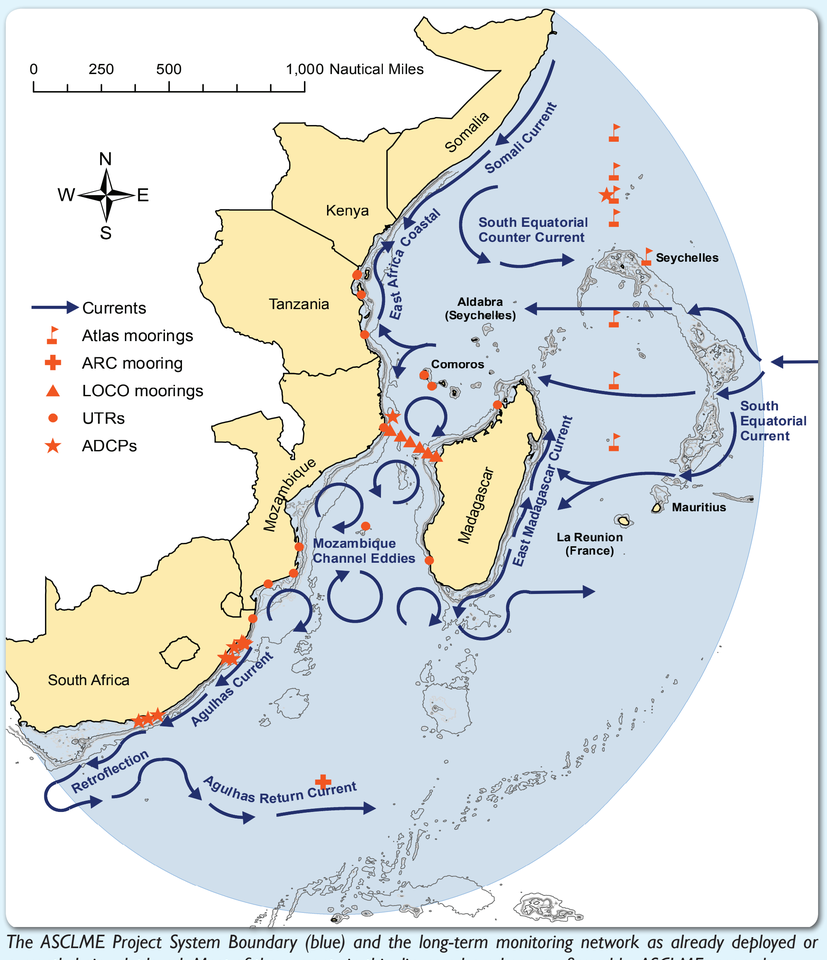
The conclusion of this scenario is an urgent need to develop focused early warning and continuous long-term monitoring networks, particularly in relation to critically vulnerable ecosystems and communities, and particularly in those areas of the world that are expected to be most vulnerable to such changes. These need to be sustainable and sufficiently credible in their data and information outputs to be able to drive reliable predictive mechanisms for adaptive management and governance. The Large Marine Ecosystems of the world are seen to be directly related to major global physical phenomena with a particularly close linkage to climate in terms of ocean-atmosphere interactions Specific indicators within Large Marine Ecosystems need to be selected that will act as early warnings of ecosystem variability and climate change at a global, regional and local level.



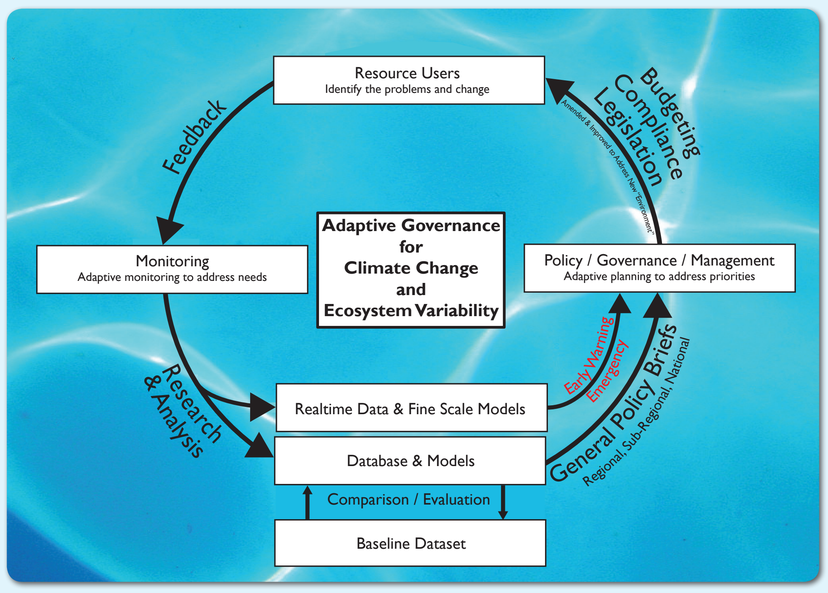
There will be fifty million climate refugees by 2010; 200 million are predicted by 2050.

Potential Impacts:
Alteration in current regimes
Change in water temperatures and salinities
Sea level rise
Increasing extremes in pH (ocean acidification)
More frequent and greater storm surges

Potential Effects:
Transboundary migration of fin-fish stocks
Deterioration/loss of shellfisheries
Loss of planktonic species
Loss of coral reefs
Migration of critical habitat types and species
Loss of coastal resources and habitats
Losses/changes in food resources
Threats to national and regional economies
Community instability



The ASCLME Project System Boundary (blue) and the long-term monitoring network as already deployed or currently being deployed. Most of the currents in this diagram have been confirmed by ASCLME research.



Expected Impacts of Climate Change and Ecosystem Variability

Global climate changes, and the resultant impact on marine ecosystems, are expected to have a significant effect on coastal communities around the world within the next 10-20 years.

These biophysical changes will cause significant socioeconomic changes as a result of coastal land loss, changes in coastal resources (species types, number and biomass, distribution, accessibility), etc. Such changes will inevitably induce loss of livelihoods, reductions in food security and food access, and a general decline in quality of life, health and well-being among coastal communities.

Impacts can also be expected further inland as a result of changes in average climatic conditions which will be reflected in low rainfall levels and seasonality, winds and temperature, all of which will in turn affect agriculture and living conditions for many populations which may be relatively far-removed from the coastline.

The 2007 report of the Intergovernmental Panel on Climate Change predicted a rise of between 2-6.4°C before the end of this century. However, a former chair of the IPCC has warned that the world should sensibly be preparing for a 4°C warming scenario over this period, The journey into a new and ultimately hotter world has, in essence, already begun and effects will almost certainly become apparent within the next 20-30 years.

Impacts from climate change will be scale-dependent and can be expected to be unevenly distributed within communities and countries as a result of different levels of exposure and vulnerability.

Poverty-stricken areas in Africa and Asia are likely to be the most affected. The world can expect a new order of "climate refugees" within the next decade.

Climate Change and Large Marine Ecosystems

The Linkages:

Ecosystem-based management of marine resources, particularly through the Large Marine Ecosystem approach, requires a detailed understanding of the ocean-atmosphere linkages that also drive the global climate.

Understanding and sustaining LME processes is therefore critical to the understanding and maintenance of climatic stability. Conversely, changes in climatic conditions will almost certainly cause entire ecosystems to 'shift' in terms of their physicochemical and biological characteristics as well as in terms of their boundaries and extent. Variations in climatic stability and the 'knock-on' effect of climate change will have adverse consequences for LMEs and their ocean-atmosphere linkages.

Monitoring of LMEs is therefore a valuable tool for understanding ecosystem variability and the impacts caused by climate change.

The Problem:

Despite the clear importance of understanding and monitoring such changes at the ocean-atmosphere level as well as the associated impacts, there is a problem…

- Oceans have been largely ignored in the climate change agenda
- Mitigation and adaptation discussions fail to include the need for preliminary baseline and monitoring processes
- Climate models/scenarios are too broad for any useful planning and adaptation - Predictions are global and not regional/local in nature
- Therefore, vulnerability assessments are failing to address scales fine enough to provide adequate community-focused guidance for adaptive management
- Policy makers and managers must have reliable advice or predictions upon which to prioritise actions and budgeting at the national/local level
- Living marine resource management must be more adaptive

The ASCLME Project: Addressing the Problem

Over the next five years, the nine countries of the western Indian Ocean region, including Comoros, Kenya, Madagascar, Mauritius, Mozambique, Seychelles, Somalia, South Africa and Tanzania, will work together through the Agulhas and Somali Current Large Marine Ecosystems (ASCLME) Project.

The aim of the Project will be to deliver a Strategic Action Programme at the LME level leading to the adoption of long-term governance mechanisms including continuous monitoring of indicators that will provide:

1. Early warning for Ocean-Atmosphere changes and Ecosystem Variability
2. Clear Indicators of Changes and Trends in terms of Millennium Development Goals or Priorities identified in the World Summit on Sustainable Development - Programme of Implementation

ASCLME Ecosystem Assessment Data Capture

Meteorological and Hydrographical Sampling
Plankton Sampling
Biological Fish Sampling
Acoustic Surveys
Coastal Habitat Types
Coastal Livelihoods Mapping and Assessment
Invasive Species
Marine Pollution

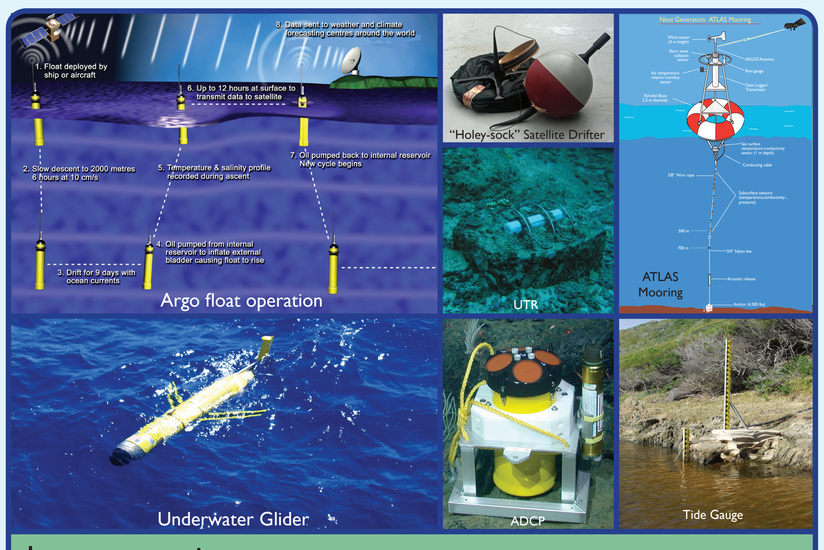
ASCLME: Meeting the Challenge through its Deliverables

1. Continue with baseline data collections
2. Ecosystem and Climate Variability Indicators adopted
3. A Long-Term Monitoring and Early Warning System adopted
4. Spatially focused, fine-scale predictive modeling mechanism developed
5. National & Regional Policy and Managerial briefing documents for adaptation

The ocean sunfish, Mola mola, *is the mascot of the ASCLME Project. Present throughout the study region, this species drifts slowly on the ocean currents, irrespective of national borders. This echoes the aims of the Project to study the ecosystem of the western Indian Ocean and encourage a long-term, transboundary, ecosystem-based approach to management.*

Partnerships

In order to achieve these deliverables, the UNDP/GEF ASCLME Project is working closely with a number of international and regional partners (ACEP, WIOMSA, IRD, FAO, Royal Netherlands Institute for Sea Research). Principal among these partnerships is an evolving and mutually valuable relationship with NOAA (National Oceanic and Atmospheric Administration, USA). NOAA is providing much of the physical instrumentation for building this long-term monitoring and early warning network and assistance with data processing, while ASCLME is providing the platforms for deployment and maintenance as well as the linkages to governance and policy briefs.



Instrumentation

The long-term monitoring network will rely extensively on a network of instrumentation throughout the region, including ATLAS buoys, Argo floats, satellite drifters, ADCPs, Underwater Temperature Recorders (UTR) and underwater gliders/AUVs. An inshore, country-based monitoring network and remote sensing will complement this *in situ* offshore network.
Particularly exciting is the partnership with NOAA and the linkage to RAMA.
For more information on RAMA, please see McPhaden *et al.* 2009. RAMA The Research Moored Array for African-Asian-Australian Monsoon Analysis and Prediction. *BAMS* **90**, 459-480.

Research Platforms

The ASCLME Project uses several research vessels to conduct its surveys. The most used are the Norwegian vessel *Dr. Fridtjof Nansen*, through FAO's EAF-Nansen Programme, and the South African vessel *Algoa*, in partnership with Marine and Coastal Management and the African Coelacanth Ecosystem Programme (ACEP).

www.asclme.org/oceanobs09/

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