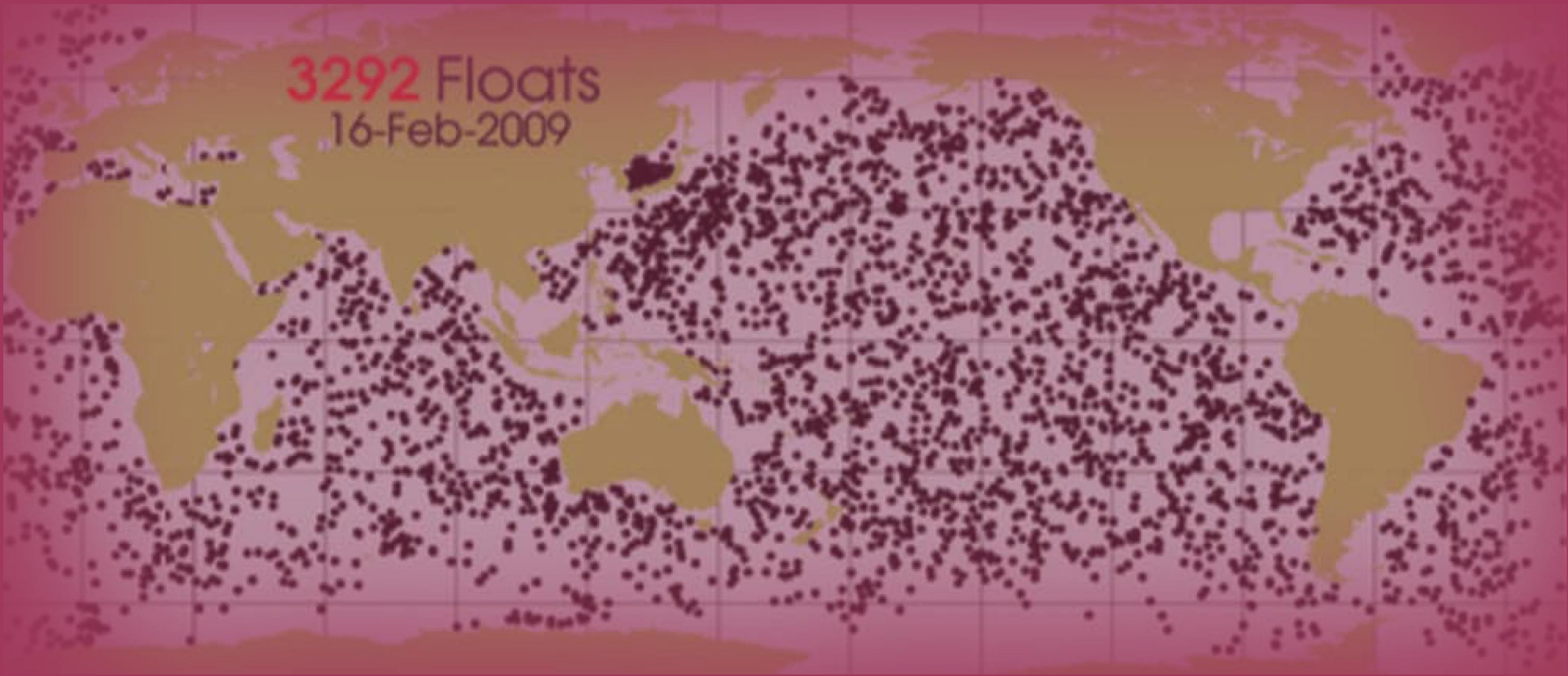
6 Ocean Data Applications: Examples from Africa



6 Ocean Data Applications: Examples from Africa

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A better understanding and management of the marine environment require improved access to data and information by government agencies. Such data and information helps nations in prudent and sustainable exploitation of marine resources, forecasting events, improving safety at sea, and mitigation of disasters such as tsunamis.

A survey by the Ocean Data and Information Network for Africa in 2006 revealed a wide range of data and information requirements. Covering physical, biological, meteorological, geological, and chemical aspects of coastal and marine science (Table 1). Though, it was evident all the countries surveyed regularly collect some amount of the various data types, none however has the capability to generate adequate data for optimal management of its coastal and marine environments. The need to share data across countries therefore is necessary to help mitigate the paucity of data and information. The problem also has an in-country dimension. In several of the countries surveyed, data collection is often duplicated and existing datasets not shared, or other relevant sectors and agencies may not be aware of their existence.

In this chapter, examples of the application of ocean data and information are presented to help increase awareness on the importance of such efforts.

Forecasting Events

Event forecasting depends on availability of quality data as well as the ability to model them. In certain instances, rapid dissemination of real time data is paramount, as is the case with tsunamis for example.

Figure 1. Data and information requirements for Integrated Coastal Area Management, identified during the ODINAFRICA survey in 2006. The listed data types and end users are not shown in any order of priority.

Typical end-user	Data /Information type
Fishing industry	Weather forecast, storm surge forecast, tides forecast, maps of fishing grounds, upwelling strength prediction, fish catch statistics, marine traffic guides, pollution indices
Governing authorities (regional, district and local authorities)	Effluent discharge rates/models, erosion/sediment budget models, fish catch statistics, land use/land suitability maps, population census data
Ports and harbours authorities	Tides forecast, storm surges forecast, sediment budget models, current maps, oceanographic charts (bathymetry and navigational hazards, etc), marine traffic guides
Tourism sector	Tides forecast, game fish atlas, thematic maps on lagoons, estuaries, beaches (i.e. location, water quality, permitted recreational use (i.e. bathing, fishing, etc), type of wildlife available, etc), environmental sensitivity maps, bio-geographical maps, species list for ecotourism and land use maps
Water sector	Coastal aquifer recharge/salt water intrusion information
Navy and maritime authority	Tides forecast, storm surges forecast, sediment budget models, current maps, sea density, oceanographic charts (bathymetry and navigational hazards, etc), marine traffic guides
Industry (offshore oil and gas)	Seismic survey data, weather forecast, current regimes, bathymetry, environmental sensitivity maps, physiographic/hazard maps, marine traffic routes
Researchers academics and non-governmental organizations	All of the above

Predicting changes over a longer period, such as potential sealevel rise and shoreline change, does not necessarily require realtime data. This said, it does need vast amounts of data from multiple sensors and studies, including tide data, for the time period addressed.

Tsunami

Long wavelength moving waves caused by quick displacement of ocean water are called tsunami, a Japanese word combining tsu (harbour) with nami (wave). When the waves reach shallower waters, wave height greatly increases and the water can surge ashore like a very fast high tide causing a potentially giant catastrophic wave. Earthquakes under the sea, landslides, and volcanic eruptions can all can create tsunamis.

Tsunami waves travel long distances. With modern sensors deployed around the globe, it is possible to alert coastal countries of an imminent tsunami threat and enable precautions to be taken to save life and property. Knowledge of local tidal information could make a significant difference to the potential impacts of a tsunami. If the estimated arrival time of a tsunami wave happens to coincide with the time of the local high tide, the predicted wave height will be of a higher magnitude, and impacts would be correspondingly more severe. Thus, not only information of the propagation of the wave is vital, but also the predicted local tidal data which helps in a determining the extent of the disaster.

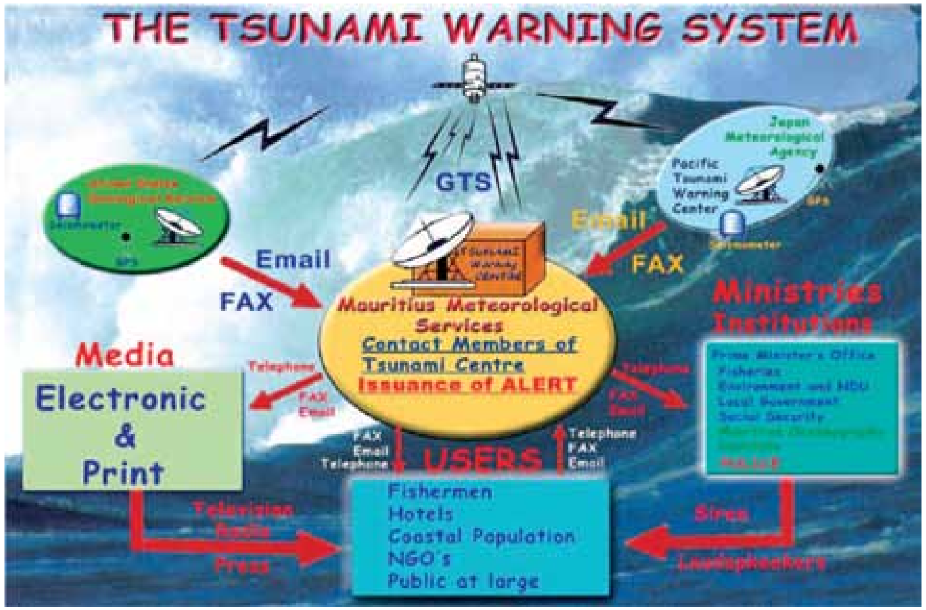

Figure 2. The Tsunami warning system of Mauritius.

Sea Level Rise and Shoreline Change

Tide data are important in many ways in both global and national contexts. Globally, they are particularly important in estimating how

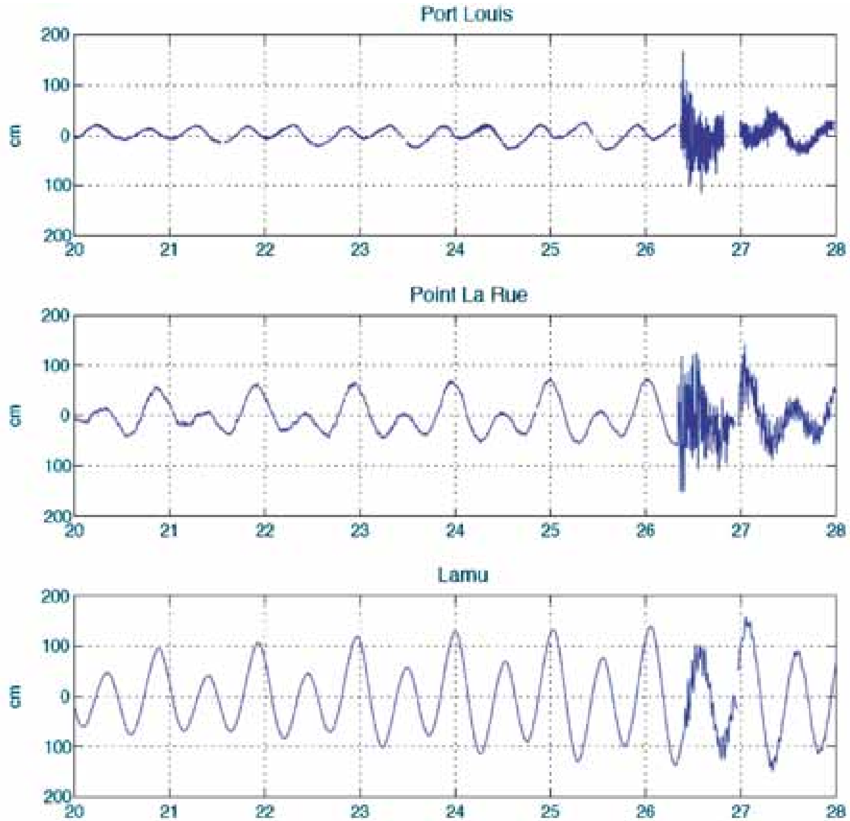

Figure 3. Tidal stations data during the Indian ocean tsunami of December 24, 2004 from Port Louis (Mauritius), Point La Rue (Seychelles), and Lamu (Kenya).

fast the sea level is potentially rising. At national, or even local scales, raised sea levels may exacerbate shoreline erosion and recession rates. Therefore, tide data must be included in such models, particularly in areas where sediments are unconsolidated. Coastal planners and developers may use such predictions for determining the best sites for planned developments, such as building of new cities and important infrastructure.

Ocean and sea surface temperature (SSTs) data

One of the most common parameters collected from the marine environment is temperature. Temperature data is obtained either directly with probes or remotely from satellites. Ordinary thermometers as well as more sophisticated tools like expendable bathythermographs (XBTs), and satellite – linked Argo floats and buoys are now deployed globally to provide sub-surface, sub-sea surface temperature data and other data.

Expendable Bathythermographs (XBTs)

XBTs are launched from the bridge of ships using a hand launcher to monitor the upper ocean thermal structure along several transects in all ocean basins (Figure 4). The data are logged to a computer, where it is processed and formatted for satellite transmission in real-time through the Global Telecommunications System (GTS). The data are then used by national and international organizations, universities and government laboratories for weather and climate forecasting, and for climate research.

ARGO Floats

Another temperature data recorder is the Argo float (Figure 5). Most ARGO floats drift at a depth of 2 000 m for about 10 days, and then make a profile of temperature and salinity from 2 000 m to the surface. The float then stays at the surface for about 5 hours sending the data to a satellite, descending afterwards to the resting depth of 2 000 m (Figure 5).

Figure 4. XBT (left) being shot into the sea off the Ghana coast (right).

Both XBTs and floats provide vital observations to estimate the heat contained in the upper ocean and the surface currents which drive the sea surface temperatures. These are critical ocean variables determining the locations of high and low atmospheric pressure systems. The understanding of the upper ocean temperatures provided by XBT observations is vital for better forecasts of marine weather. Several thousand ARGO floats have been deployed worldwide (Figure 6).

Coral bleaching

Corals are colonial animals and the individuals, called polyps, are very similar to tiny sea anemones. They grow in warm, clear, shallow waters with optimal temperatures of 23^0 to 25^0C. The polyps harbour in their tissues symbiotic masses of single-celled algae called zooxanthellae. The coral provides the algal cells with a protected environment and nutrients for growth as well as carbon dioxide. The algal cells photosynthesise returning oxygen and removing waste. Under certain

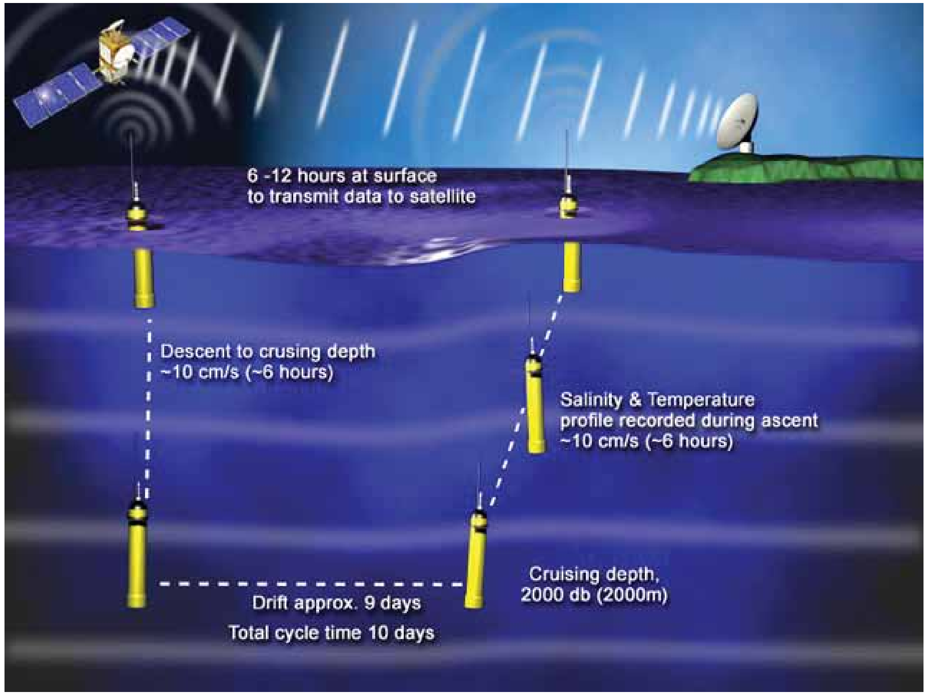

Figure 5. Diagrammatic representation of how an ARGO float works (available at UCSD: http://www.argo.ucsd.edu, accessed on the 8th May 2009).

unfavorable conditions, such as increased sea temperatures, the corals become stressed and expel the algal cells. They become quite pale, a condition described as coral bleaching.

Data on ocean temperature may help explain certain catastrophic ecological events. Elevated temperatures, for example, have been implied in instances of coral bleaching in Tanzania (Figure 7.) and continuous monitoring of sea temperature would serve as an early signal to onsets of coral bleaching and death.

Sea surface temperature (SST), upwelling strength and marine productivity in the Gulf of Guinea

Small pelagic fisheries constitute the main source of livelihood for several coastal communities of the Guinea Current area in West Africa.

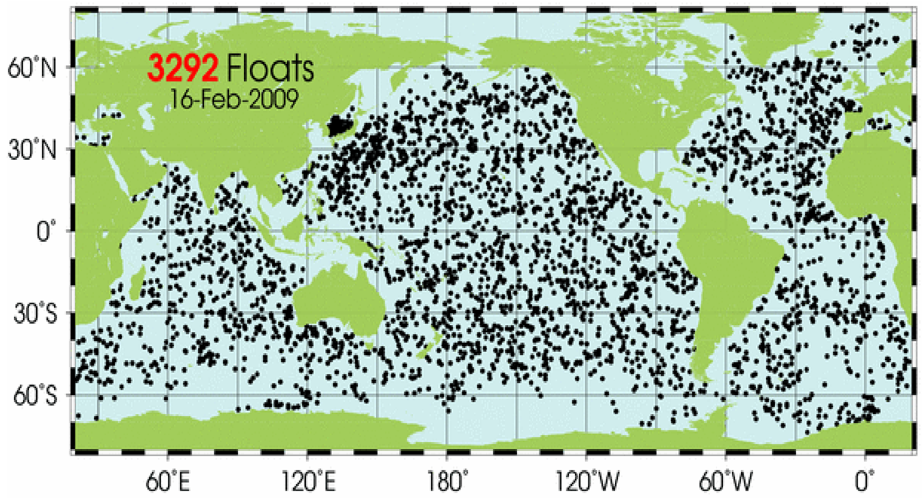

Figure 6. Global coverage of ARGO floats (available at UCSD: http://www.argo.ucsd.edu/FrAbout_Argo.html accessed on 16th February 2009).

Figure 7. The daily mean seawater temperature records on coral reefs off Zanzibar town (1997 -2002). The higher temperatures in March – May 1998 coincided with coral bleaching in the study area. (Source: Muhando, 2002).

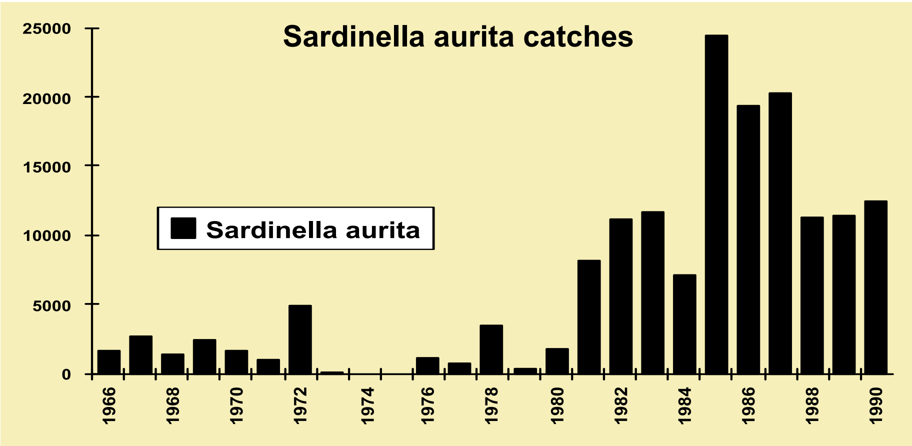

Figure 8. Sardinella aurita catches off Cote d'Ivoire from 1970 to 1990.

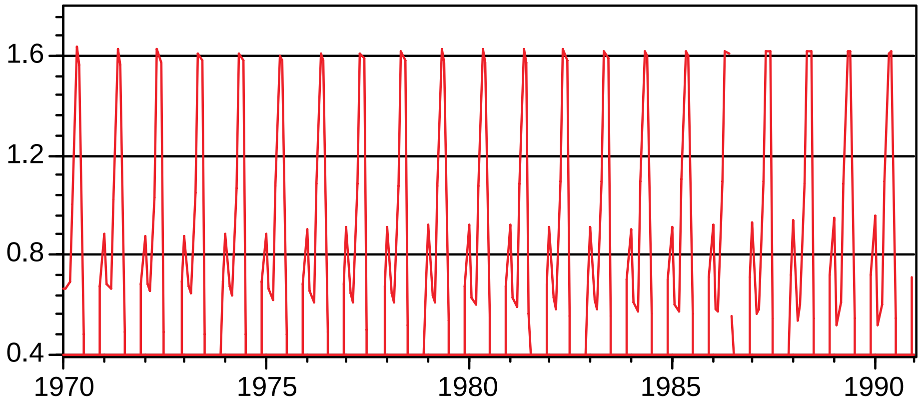

Figure 9. SST anomalies off Côte d'Ivoire from 1970 to 1990.

The success of the fishery depends on the strength of the upwelling. Because strong upwelling periods are associated with the duration and spatial extent of upwelled colder water, data on near shore temperatures may be useful indicators for forecasting the success of the fishery.

A good example is illustrated by the catch statistics from Cote d'Ivoire and SST anomalies measured from 1970 to 1990 (Figures 8 and 9). Increases in the strength of the upwelling, indicated by the amplitude

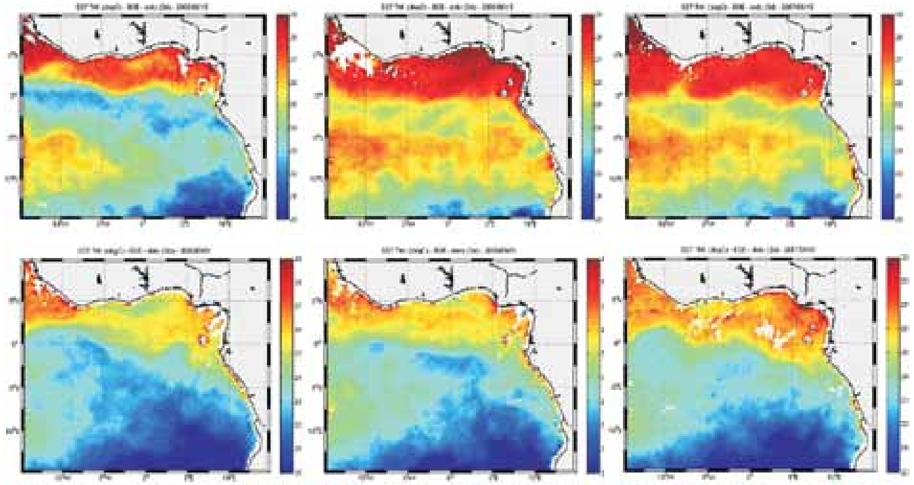

Figure 10. Upper panels: sea surface temperature on June 15th 2005 (left), 2006 (middle) and 2007 (right). Lower panels: same for September 1st 2005 (left), 2006 (middle) and 2007 (right) Courtesy Dominique Dagorne and B. Bourles; TMI/TRMM data) Aman et al. (2008).

of the SST anomalies, appear to correlate with the rise in catches of *Sardinella aurita*, the main species caught by the small pelagic fishery Figures 8 and 9).

SST and regional climate of West Africa

SSTs in the Gulf of Guinea vary at seasonal and inter-annual time scales (Figure 10), and may have a strong impact on regional climate (west Africa monsoon onset and intensity), precipitation i.e. water resources (Figure 11), and fisheries. In particular, the coastal upwelling may have a regional impact on air-sea exchanges and thus on precipitation during the West African monsoon period.

Knowledge and availability of near real-time data on SSTs in the Gulf of Guinea can be applied in forecasting rainy (wet) years or drought (dry) years in the west African hinterland influenced by the monsoon.

Regional scale SST data therefore can be useful in predicting to reasonable extents probable wet and dry years. This in turn could assist in the formulation of critical management strategies for certain national sectors, such as power use from hydroelectric dams, as well as the security of rain-fed agriculture in west Africa.

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