

## **Global Environmental Change affecting Sustainable Development of the Coastal Zone in Mauritius.**

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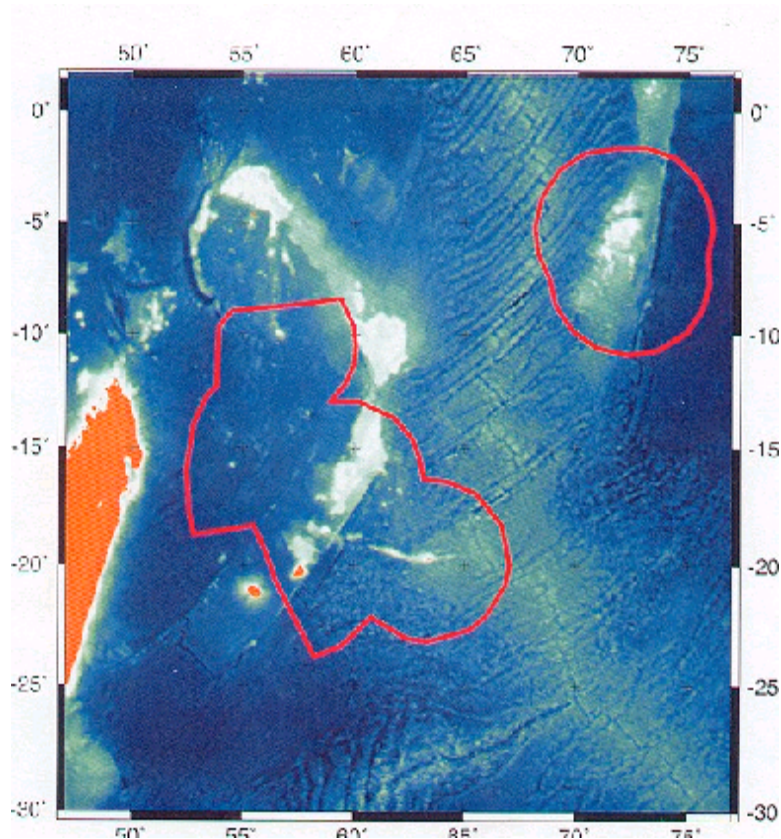
### Abstract.

Mauritius is at a critical juncture in its socio-economic evolution and the sustainability of its marine resources and the conservation of its exceptional biological diversity depend on a critical understanding of linkages between human activities and ecological responses. The coastal zone of Mauritius was redefined in 1997 in the Environment Protection Act of 1991 (Part VII [Act34]) to include all islets within the EEZ some of which can be developed for ecotourism. The limits of the EEZ of Mauritius (1850 km<sup>2</sup>, 20°S, 58°E, South Western Indian Ocean, 1.12 million inhabitants) have been defined by geographical coordinates through subsequent regulations under the Maritime Zones Act 1977 as the Maritime Zones (EEZ) Regulations 1984. Mauritius has proclaimed its Territorial sea (12 nm) through the Territorial Sea Act of 16 April 1970, its Exclusive Economic Zone (200nm, about 1.9 million sq km) around the islands of Mauritius, Rodrigues, Agalega, Cargados Carajos shoals, Chagos Archipelago and Tromelin and has also defined its continental shelf through the Maritime Zones Act 1977. Galvanized by the United Nations Conference on Environment and Development meeting of 1992, there has been a search for methods to build capacity of coastal nations and communities to manage their coastal and estuarine resources in a sustainable manner in Mauritius. Minor coral bleaching was observed around the Mauritian coast in April 1999 and some lagoons along the Eastern Tourist Zone have suffered from eutrophication through submarine groundwater discharge. There is presently an urgent need to further protect sensitive marine and coastal areas under ICZM.

**Keywords:** Sustainable development, Coral Bleaching, Submarine Groundwater Discharge, ICZM.

## Introduction.

Mauritius is at a critical juncture in its socio-economic evolution. The sustainability of its marine resources and the conservation of its exceptional biological diversity depend on a critical understanding of linkages between human activities and ecological responses. International collaboration that addresses biological and economic dynamics through a series of descriptive, experimental, and modeling studies is vital. No such thing has ever been done before, yet without this type of analysis the concepts of ecological and economic sustainability are intrinsically meaningless. The limits of the EEZ of Mauritius (1850 km<sup>2</sup>, 20°S, 58°E, South Western Indian Ocean, 1.12 million inhabitants) have been defined by geographical coordinates through subsequent regulations under the Maritime Zones Act 1977 as the Maritime Zones (EEZ) Regulations 1984. Mauritius has proclaimed its Territorial sea (12 nm) through the Territorial Sea Act of 16 April 1970, its Exclusive Economic Zone (200nm, about 1.9 million km<sup>2</sup>) around the islands of Mauritius, Rodrigues, Agalega, Cargados Carajos shoals, Chagos Archipelago and Tromelin (Fig. 1), and has also defined its continental shelf through the Maritime Zones Act 1977. At present there is a need for Mauritius to compute the outer limits of the EEZ, produce charts showing baselines and list of geographical coordinates of the basepoints, specifying geodetic datum and submit a claim for an extended continental shelf beyond 200nm to UN Commission on the limits of the Continental Shelf by November 2004.



**Figure 1. Exclusive Economic Zone around Mauritius.**

### **Coral Reefs and Submarine Ground water Discharge.**

The world's coral reefs and other sensitive coastal habitats are in steep global decline precipitated by anthropogenic activities, and by interactions between these activities and natural cycles of growth and decay. This is of great concern because coastal habitats- and coral reefs in particular- house the majority of marine species, are highly productive, and are essential to life for a large proportion of the world's human population, both rich and poor. The coastal environment of Mauritius also receives significant submarine groundwater discharge (SGD), the seepage of fluids through coastal marine sediments from the underlying aquifer into the overlying coastal ocean. SGD is typically a mixture of two sources, including seawater cycling within submarine sediments and groundwater discharge from terrestrial aquifers. This last component of SGD provides a conduit for anthropogenic constituents from the terrestrial environment to enter the marine environment. The main studies on the shallow water marine and coastal habitats of Mauritius have been conducted by Baissac *et al.* (1962), Hodgkin and Michel (1963), Pichon (1971), Salm (1976), Montaggioni and Faure (1980), Fagoonee (1990a,b), and recently a series of ecological and hydrographic surveys of lagoons by Torres (1997), Walley (1997), Muller (1998), Ingrams (1998), Daby (1999) and Ramessur (2004). Satellite remote sensing was employed in a series of studies to classify and quantify the coastal marine habitats and the data has been embedded in a Geographical Information System (Eastwood, 1998; Hardman, 1999). Lagoons have good exchanges with the open ocean and are significantly influenced by tidal variability. The banks and shoals of the Mascarene Plateau have extensive coral growth areas and support a very important fishery, which can be exploited by hand lining and basket traps only. The islands of Rodrigues and Mauritius are surrounded by coral reefs but have no continental shelves and deep water occurs close to their coasts. The main coastal features include basaltic rock shores, coral reefs, lagoons, sand beaches, estuaries, wetlands and mangroves.

### **Artisanal and Bank fishery.**

The artisanal fishery is the traditional fishing carried out in the coastal waters around Mauritius. Some 3000 professional fishermen exploit two distinct fishing zones: lagoon and off-lagoon. Annual landings had stabilised to around 1600 tons in 1996, but a decrease occurred in 1997 due to a reduction in the total number of registered fishermen. Fishermen land their daily catch at specific landing stations (a total of 61 around the coast) designated by law. There is a tacit arrangement between the fishermen and the fishmonger concerning sale of fish and supply of fishing gears. Fishing by 200-300 fishermen around 17 Fish Aggregating Devices (FADs) deployed between 2 and 12 nautical miles offshore has gained in importance since 1985. Catch rates (10-20 kg) are better than lagoon fishing and annual landings amount to about 400 tons. Fishing methods and gears include line, basket trap and net (seine net, gill net, cast net) and other unconventional gears (bait net, carnard net, shrimp net, harpoon), and a closed season operates for deployment of nets. The principal fish types caught include Siganids (13%), Scarids (12%), Lethrinids (11%), octopus (10%) and sharks.

The banks are fishing areas located along the Mauritius Seychelles Ridge and include the Saya de Malha and Nazareth Banks and the St Brandon group of islands. The banks fishery is the most important source of frozen fish for Mauritius and represents 70% of the total production for direct consumption. The catch from the banks

constitutes 90% of Lethrinids, namely 'Dame Berri' (*Lethrinus mahsena*) and 'Caya' (*Lethrinus rubrioperculatus*). The remaining 10% consists of 'Carangues, Vacoas, Croissant, and Vieilles'. A licencing system exists since 1992 to manage the fishing activities on the banks. The annual production currently stands at about 4000 tons of frozen white fish. Production was about the same a decade ago but it rose to 5500 tons during the period 1993-1995 and stabilised to the former level again.

### **Industrial fishing.**

Tuna fishing operates on an industrial scale since 1952 in the South West Indian Ocean with Japanese, Taiwanese and Korean fleets of purse seiners and long-liners. Mauritius and France joined the fishery in the early 1980s and this has now expanded substantially, with annual landings of over 265,000 tonnes. Port Louis has served as a tuna transshipment base since 1965. In Mauritius the tuna fishery accounted for about 35% of the total annual catch of fish in 1997 and forms the basis of an important canning factory. Export of canned tuna represents more than 90% of the export of Mauritian fish and fish products. Only one out of three Mauritian purse seiners is in operation since 1997. The average composition of the main species caught were as follows: skipjack (*Katsuwonus pelamis*): 66.7%, yellowfin (*Thunnus albacares*): 23.7% and bigeye (*Thunnus obesus*): 9.6%. Mauritius has recognised the potential for both a long-line sword fishery and a deep water shrimp fishery (*Heterocarpus laevigatus*) using traps in 600-1000 m depth (AFRC, 1996). Sports fishing remains an important attraction with a total annual catch of around 400 tonnes, consisting of bill fish, tuna and shark. Illegal fishing have also been reported in the Western Indian Ocean.

### **Global Environmental Change and Coral Bleaching.**

The extraction of 500,000 tonnes of lagoonal coral sand annually by manual methods has been damaging the seabed and its inhabitants, altering the seafloor geometry to allow bigger waves to reach the shore and thus causing widespread beach erosion. Other effects include smothering of benthic communities by the fine clogging sand in suspension as well as reduced primary productivity. Thus, a ban was imposed on extraction of shallow depth marine sediments in October 2001 and is viewed as a vital measure towards lagoon rehabilitation in Mauritius.

One visible effect of Global Environmental Change has been the unprecedented bleaching event of 1998 affected up to 90% of many shallow living corals throughout the Indian Ocean region, massive mortality occurred in the Seychelles (Turner *et al.*, 2000c), Chagos Archipelago and St Brandon (Sheppard, 1999b) and along the East African coast (Linden and Sporrang, 1999), and many of these reefs have now eroded to rubble. Mauritius also experienced raised sea surface temperatures of 1 to 1.25°C during February 1998 but mass bleaching of corals did not occur due to high cloud cover, high rainfall and low sunshine during the passage of cyclone Anacelle (Turner *et al.*, 2000b). Severe coral bleaching and mass mortality that would have occurred due to the synergistic effects were mitigated by the cyclone. The most likely impacts of reef degradation due to coral bleaching in Mauritius will be on the two common socio-economic reef based activities, namely fisheries and tourism: (1) artisanal catch rates may decrease and the catch composition may shift towards the herbivorous species. (2) the target species of the offshore FADs are the large predatory pelagics that forage near the reefs on reef fish, so these devices may also offer lower catch rates (Pet-Soede, 2000), (3) major shifts in the ecology of these small scale fisheries

may occur due to over-exploitation pressure, (4) the fishermen may no longer disperse their effort over larger areas to decrease fishing effort locally, and (5) being a beach, dive and snorkel destination, Mauritius is classed as having a high level of reef-based tourism because over 70% of the total tourists take part in reef-based activities (Westmacott and Cesar, 2000). The actual number of tourists due to coral bleaching does not seem to have been impacted.

### **Ecotourism.**

Tourism, particularly coastal and marine based, is among the most important sectors of the Mauritian economy as a source of foreign income with around 700 000 visitors annually in 2004. The widely practised types of tourism include beaching, swimming, snorkelling and diving, boating, skiing, parasailing and gamefishing. The coastal sites chosen for tourism are largely exploited for their beauty and exoticism, aesthetic value and natural habitats with remarkable biodiversity (e.g. coral reefs, sand beaches and dunes, warm, clear and attractive lagoon water). The rapid expansion of the hotel industry has brought economic benefits both to the public and private sectors. Increasing environmental and human dimension concerns are being voiced out about the pace and scale of hotel development. From an environmental perspective, hotels and other tourist infrastructures are spoiling the coastal landscape and the natural environment. This is very much in contradiction to the current global trend which indicates increasing emphasis on ecotourism.

There is at present a need to manage the 49 inshore islets around Mauritius. A national task force have made recommendations to the government in June 2001 for the creation of an islet authority and to declare 16 of the islets as Islet National Parks in the long term. Many of the islets are under-utilized and many of them through a proper land use zoning can be used for conservation, education, recreation and ecotourism projects. The main piece of legislation for providing for the protection and management of offshore islets in Mauritius are: Forests and Reserves Act 1983, Wildlife and National Parks Act 1993, Pas Geometrique Act 1895 and the State Lands Act 1874. The 49 islets have been grouped into 3 categories- Strict nature reserve with restricted access, open nature reserve with controlled access and tourist and recreational with free access. Many of the offshore islets are biologically important and have conservation potential due to their unique native and endemic flora and fauna.

### **Integrated Coastal Zone Management in South Western Indian Ocean Island states.**

Galvanized by the United Nations Conference on Environment and Development meeting of 1992, there has been a search for methods to build capacity of coastal nations and communities to manage their coastal and estuarine resources in a sustainable manner. Following ICZM (1993) in Arusha Tanzania, where ministers of the South Western Indian Ocean nations signed a Convention, the Seychelles Statement (1996) and the Colombo CZM workshop (1999), the need for ICZM has become critical because of limited land resources and unproportional domination of coastal areas (Fagoonee and Daby, 1995; Ramessur and Fagoonee, 1999). During the 1980s, the Mauritian economy underwent major structural changes successfully with a rapid phase of industrialization and urbanization with the threat of contamination of surface waters in Mauritius and deterioration in water quality by industrial wastes, in particular, metal pollution, being only relatively recent as compared to industrialized countries (Ramessur *et al.*, 2001; Ramessur and Ramjeawon, 2002; Ramessur, 2002;

Ramessur 2004). The coastal zone of Mauritius was redefined in 1997 in the Environment Protection Act of 1991 (Part VII [Act34] to include all islets within the EEZ. Mauritius has also ratified and adhered to international law or legal instruments.

### **Coastal and Ocean studies for Sustainable Development.**

One of the highlights of the Indian Ocean Global Ocean Observing system (IOGOOS) in 2002 has been the signing of a Memorandum of Understanding by members, on an agreement to formally establish an IOGOOS Regional Alliance composed of Indian Ocean Rim countries as well as other countries outside the region with an interest in the Indian Ocean and to foster co-operation towards the development and strengthening of operational oceanography in the Indian Ocean.

During the Ocean and Climate Workshop it is felt that there is a need to consolidate and extend regional networking; establish links with Indian Ocean Coastal GOOS; identify actions required to move toward an Implementation Plan for the Indian Ocean building on the SOCIO Workshop, meetings of the CLIVAR Asian/Australian Monsoon Panel, and the GODAE Science Team and identify the potential regional users for operational products derived from the observing system.

There is also a need to establish working relationships between IOGOOS, LOICZ and other regional bodies (e.g., Regional Seas Conventions, Regional Fishery Bodies, Large Marine Ecosystem Programmes); initiate a process that will lead to the establishment of a regional network (or networks) of coastal laboratories to initiate the development of a Coastal Observing Network for the Near Shore (CONNS) for the design and implementation of the coastal component of the IOGOOS; identify phenomena of interest that are high priorities in the region or regions (e.g., the coastal zones of the Arabian Sea, Bay of Bengal and Mascarenes Plateau regions) and that require sustained observations on a regional scale and to formulate Proof of Concept Pilot Projects. There is also a need to present information on data management in the Africa region (ODINAfrica) and identify a plan for data management in the Indian Ocean region; to provide examples of satellite applications in the Indian Ocean region and plan expanded use of satellite applications, improved collaboration and capacity building for sustainable development and use of resources.

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