



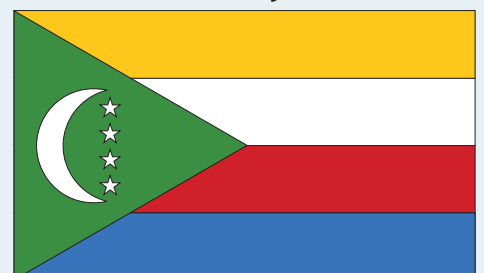
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# Union of Comoros



## National Marine Ecosystem Diagnostic Analysis (MEDA)

Agulhas and Somali Current Large Marine Ecosystems (ASCLME) Project





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## Executive Summary

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1. The Union of Comoros consists of four volcanic islands with a total coastline of about 225 Km. These islands are, from west to east, Grande Comore (1148 Km<sup>2</sup>), Moheli (290 km<sup>2</sup>) Anjouan (424 Km<sup>2</sup>) and Mayotte (374 Km<sup>2</sup>). The whole archipelago covers a total surface area of 2236 km<sup>2</sup>. The Exclusive Economic Zone (EEZ) is estimated to be more than 160 000 Km<sup>2</sup>. The EEZ covers 900 Km<sup>2</sup> of continental shelf and 427 km of coastline. The climate is tropical humid with oceanic influence in two seasons. It is subjected to three successive regimes of wind: (i) the north-west monsoon/trade winds or Kashkazi, (ii) local winds from the south-west originating from the southern high pressures and, (iii) the south-east monsoon/trade winds or Kusi. The country is vulnerable to climate change. The average annual temperature is 25.3°C at sea level and the lapse rate is about 0.6°C per 100 m. Despite the presence of two seasons, the average temperature varies little throughout the year. At low altitudes, average temperatures in the cool season are from 23 to 24°C and the maximum is around 28°C. The minimum temperature ranges from 18 to 19°C.
2. The Comorian population is estimated at 705,376 inhabitants with a population growth rate of about 2.1% per annum (RGPH2003 projection 2011). The average population density is 269 inhabitants/km<sup>2</sup>. The population density varies significantly from one island to another and within the islands. The population of Comores originated from Africans, Indonesians, Persians, Arabs and Malagasy in different proportions depending on the region. These ethnic groups are now strongly mixed. Out of this mixing was born a rich cultural homogeneity. The Comorian society deeply promotes community solidarity and maintenance of its cohesion in many rites which all people are free to participate.
3. The Union of Comoros is one of the Small Island Developing States (SIDS) with a GNP per capita of 450 USD. The island is ranked 139th out of 177 countries with a Human Development Index (HDI) of 0.547 (Global Report on Human Development 2007). The Union of Comoros is ranked among the poorest countries of the world in terms of per capita income and in terms of indicators of well being.
4. The Union of Comoros is characterized by the presence of varied ecosystems and natural resources rich in species diversity and endemism. There are at least four ecosystems: (i) a coastal ecosystem (mangroves, seagrass beds and coral reefs), (ii) a shrub-savanna ecosystem type, (iii) a forest ecosystem type, and (iv) wetland ecosystem type such as Lake Dzialandzé (Anjouan), Lake Dziani boudouni (Moheli) and salt Lake (Grande Comore). Variability of climate, geomorphology, geology and soils contributes to habitat diversity, diversity of flora and fauna including many endemic, threatened and migratory species, such as sea turtles, whales, dolphins, lemur and dugong, sea cucumbers, among others. The Comoros is also a nature sanctuary for species such as Livingstone bats and the coelacanth.
5. Problems that affect the environment in Comoros are mainly ecological fragility and limited economic development, poaching, poor agricultural and forestry practices (burning, clearing of the forest, etc), the high vulnerability to climate change and natural disasters, low responsiveness and management, as well as the narrow resource base and high costs of energy. The country is known for an increasing population pressure with limited resources.
6. Environmental problems are also caused by the rapid degradation of ecosystems; unregulated exploitation of forest resources, marine and coastal resources; increasing siltation of water resources and the exploitation of coral reefs to extract building materials including sands. Urbanization is a major problem - it is explosive, unplanned without basic community facilities. The country does not have a policy of urbanization and the consequences are land speculation, development in ecologically fragile marginal lands, destruction of natural resources, and proliferation of illegal dumping sites. Lack of an effective system of collection and disposal of waste causes an accumulation of garbage dumps and degradation of urban and coastal areas.
7. Comoros has been the subject of repeated health crises due to lack of basic sanitation and health facilities. In the last ten years, the archipelago of the Comoros has experienced series of dengue fever epidemics (1993), cholera (1998, 2001) and chikungunya (2004, 2005).

8. Since 1994, the Comoros have formulated a National Environment Policy (NEP), an Environmental Action Plan and strategies for implementation of this policy. These policies and strategies also include strategies for agriculture as well as marine and coastal resources, aimed at better management of these resources. There is also the national tourism strategy which is aimed at promoting tourism in the Comores and the Environmental Action Plan (EAP) which is aimed at promoting better environmental management. The strategy for implementation of NEP is based on establishing real partnership between government, NGOs, private sector and local communities, strengthening institutions and environmental legislations.
9. The institutional framework of the Comoros on the marine and land environment includes the national and island level frameworks. At national level, issues relating to the marine environment are managed by the National Directorate of Fisheries as well as Directorate of the Environment, the National Institute of Applied Research Fisheries and Environment (INRAPE) and practically all government ministries. At island level, the Directorate General of the Environment (DGE) and the various departments of the autonomous islands have responsibilities that include the enforcement of regulations, protecting the natural environment and controlling exploitation of natural resources. Several local NGOs are also involved in environmental protection, conservation and sustainable development.
10. The existence of the National Environmental Policy and Environmental Action Plan has enabled the country to implement important measures for environmental protection and legislation. However, for this to be effective, the government will promote education on the environment, focusing on the benefits and opportunities that can be harnessed through implementation of the policy and the action plan through media channels and educational institutions (school and universities).

## **Acknowledgements**

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## **Contributing Institutions**

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The institutions that contributed in the preparation of this report are:

Ministry of Agriculture, Fisheries, Environment, Energy, Industry and Crafts

National Institute of Applied Research on Fisheries and Environment (INRAPE)

National of Documentation and Scientific Research Center (CNDRS)

University of Comoros

Mohéli Marine Park



## List of acronyms

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AOGCM	Atmosphere-Ocean General Circulation Model
ACEP	African Coelacanth Ecosystem Project
ADB	African Development Bank
AU-WB SPFIF	African Union - World Bank Sustainable Partnerships for Fisheries Investment Fund
CAMDG	Civil Aviation and Meteorology Directorate General
CAP	Conservation Action Plan
CAP	Consolidated Appeals Process
CATI	Centre for Information Analysis and Processing
CBO	Community Based Organization
CCA	Casual Chain Analysis
CERF	Central Emergency Response Funds
CHS	Complete Household Survey
CLA	Coastal Livelihoods Assessment
COSEP	Emergency Operations and Civil Protection Centre
CRC	Comoros Red Crescent
CROSEP	Regional Emergency Operations and Civil Protection Centre
CSO	Civil Society Organization
EAF	Ecosystem Approach to Fisheries
EEZ	Exclusive Economic Zone
ERC	Emergency Rescue Coordinator
EDF	European Development Fund
EEZ	Exclusive Economic Zone
FAD	Fish Aggregating Device
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
GEF	Global Environment Facility
GIS	Geographical Information <b>(a)</b> system
GIWA	Global International Waters Assessment
HAB	Harmful Algal Bloom
ICAO	International Civil Aviation Organization
ICSD	Insular Committees for Sustainable Development
ICZM	Integrated Coastal Zone Management
IGG	Intergovernmental Groups
IMO	International Maritime Organization
INRAPE	National Research Institution for Agriculture, Fisheries and Environment
IOC	Indian Ocean Commission
IOPCF	International Oil Pollution Compensation Fund
IPCC	Intergovernmental Panel on Climate Change
IRD	French Institute for Research and Development
IUCN	International Union for Conservation of Nature
IUU	Illegal, Unreported and Unregulated
IW:LEARN	International Waters: Learning Exchange and Resource Network
JICA	Japanese International Cooperation Agency
LME	Large Marine Ecosystem
MEDA	Marine Ecosystem Diagnostic Analysis
MICS	Multiple Indicator Cluster Survey
MDG	Millenium Development Goals
MPA	Marine Protected Area
NAAP	National Climate Change Adaptation Action Plan
NAP	National Action Plan
NGO	Non-governmental Organization
NOAA	National Oceanic and Atmospheric Administration of the USA

**(b)**

NCC	National Coordination Committee
NCCC	National Comorian Crafts Centre
NCSD	National Commission for Sustainable Development
NDSRC	National Documentation and Scientific Research Centre
NED	National Environment Directorate
NHDP	National Health Development Plan
OPRC	Oil pollution Preparation Response and Cooperation
OVK	Kharthala Volcanic Observatory
PLHIV	People Living with the Human Immunodeficiency Virus
PMES	Planning, Monitoring and Evaluation Service
POP	Persistent Organic Pollutants
PRGSP	Poverty Reduction and Growth Strategy Paper
RAC	Regional Advisory Committee
ReCoMaP	Regional Programme for Sustainable Management of Coastal Zone Resources of the Indian Ocean Countries
SAIAB	South African Institute for Aquatic Biodiversity
SANA	Safety and Air Navigation Agency
SAP	Strategic Action Programme
SPFIF	Sustainable Partnerships for Fisheries Investment Fund
SSA	Sub-Saharan Africa
SWOT	Strength, Weakness, Opportunity and Threat (Analysis)
SWIOFP	South West Indian Ocean Fisheries Project
TAAF	French Southern and Antarctic Lands
TCP	Technical Cooperation Programme
TDA	Transboundary Diagnostic Analysis
TWAP	Transboundary Waters Assessment Programme
UNCLOS	United Nations Convention on the Law of the Sea
UNEP	United Nations Environment Programme
UNDSS	United Nations Department of Safety and Security
UNDP	United Nations Development Programme
UNOPS	United Nations Office for Project Services
UNS	United Nations System
WIO-LaB	Western Indian Ocean Land-based Activities Project of UNEP
WIOMSA	Western Indian Ocean Marine Science Association

## FOREWORD

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Given the importance of the marine ecosystem, the Western Indian Ocean (WIO) countries with the support of the United Nations Development Programme (UNDP) and the Global Environment Facility (GEF) participated in the implementation of the Agulhas and Somali Current Large Marine Ecosystem (ASCLME) project. This project involved generation of data and information that can be used for the protection and sustainable management of coastal and marine resources of the WIO sub region. The Marine Ecosystem Diagnostic Analysis (MEDA) of Comoros thus forms an important basis for the country's contribution towards the process of preparation of the Transboundary Diagnostic Analysis (TDA) for the WIO Region. The national process of data collection and analysis provided information on the biophysical processes that defines the large marine ecosystems and identified the specific issues that eventually fed into the Transboundary Diagnostic Analysis (TDA) as well as the Strategic Action Programme (SAP).

The GEF WIO-LaB project implemented by the United Nations Environment Programme and GEF SWIOFP implemented by the World Bank carried out in parallel also provided data and information relevant to the preparation of the regional Transboundary Diagnostic Analysis and the Strategic Action Programmes. These projects identified policy, legal and institutional reforms and investments required to address the transboundary issues that are considered to of high regional priority.

The ASCLME Project provided the Comoros with a great opportunity to generate data and information its coastal and marine environment which is has been poorly studied in the past. The project also enabled Comoros to analyse its legal and institutional frameworks as well as explore strategies for rational and sustainable management of marine resources which are of immense socio-economic importance. The management of the coastal and marine ecosystems in Comoros are facing a number of challenges not only because of their biological richness, but also because of their important role in the national economy and food security. The potential of the coastal and marine ecosystems in the provision of various goods and services is threatened by over-exploitation, land-based pollution and discharge of waste from marine transport.

## Country Overview

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The Comoros Archipelago is located in the Indian Ocean at the northern part of the Mozambique Channel, midway between the East African coast and the northern tip of Madagascar, between latitudes 11°20' and 13°04' south and longitudes 43°14' and 45°19' east. The archipelago consists of four volcanic islands, which are from west to east: Grande Comore (1148 km<sup>2</sup>), Moheli (290 km<sup>2</sup>), Anjouan (424 km<sup>2</sup>) and Mayotte (370 km<sup>2</sup>). The distance between islands ranges from 30 to 40 km. Grande Comore is 300 km away from the coast of Mozambique and the same distance separates Mayotte from Madagascar.

The Comorian population is estimated to be 705,376 inhabitants (RGPH, 2003). The population which is growing at a rate of about 2.1% per annum is very young with 53% of the total population under the age of 20 years. Life expectancy at birth is 58.3 years for males and 60.3 years for women. The vast majority of its inhabitants live below the poverty line. The Union of Comoros is one of the Small Island Developing States (SIDS) with a GNP per capita of 450 U.S. dollars. The Human Development Index (HDI) is 0.547 (Global Report on Human Development 2008). Comoros depends on agriculture, fishing and cash crops such as vanilla, cloves, ylang-ylang and jasmine.

The country is characterized by the presence of varied ecosystems rich in species diversity, endemism and natural resources. There are at least four ecosystems: (i) a coastal ecosystem types (mangroves, seagrass beds and coral reefs), (ii) a savanna shrub land ecosystem type, (iii) a forest ecosystem type, and, (iv) a wetland ecosystem type. Variability of climate, geomorphology, geology and soils contributes to habitat diversity. Comoros has many endemic, threatened or migratory species such as sea turtles, whales, dolphins, lemur and dugong, and sea cucumbers. The Comoros is a nature sanctuary for unique species such as Livingstone bats and the coelacanth. However, these species are threatened by poaching and bad practices. Problems that affect the environment in Comoros are mainly ecological fragility, poaching, poor fishing practices and agriculture, high vulnerability to climate change and natural disasters, low capacity for response and management. These problems are also caused by the rapid degradation of ecosystems and the unregulated exploitation of forest resources, marine and coastal resources, increasing siltation of the water and the exploitation of coral reefs to extract building materials, including sand whose operation is prohibited.

National strategies and legislation in the environmental sector have been developed but the capacity of government departments is limited with regard to implementing, managing and monitoring environmental action programs and in ensuring project success. The institution in-charge of the environment lacks qualified human resources and capacity to implement environmental policies and strategies.

The existence of the National Environment Policy (NEP) and the Environmental Action Plan (EAP) has enabled the country to implement important measures of environmental protection and legislation on the environment. These include the decree for the protection of flora and fauna of the Comoros, the decrees related to Environmental Impact Assessment (EIA), including the adoption of the Strategy and Action Plan for the Conservation of biological diversity, the Action Plan for conservation of Sea Turtles, and other decrees concerning the management of Moheli Marine Park.

Efforts have been made in the context of environmental protection, but the lack of capacity is the main constraint to the implementation of policies and strategies and implementation activities required to meet the obligations of environmental conventions ratified by the country. One of the challenges for the next five years is to develop the capacity for dealing with the current degradation of the environment and natural resource management.

## Biophysical Environment

### Description of the coast and distinctive features

Located in the Indian Ocean at the northern part of the Mozambique Channel, the Comoros islands are midway between the African coast and the northern tip of Madagascar, between latitude  $11^{\circ}20'$  and  $13^{\circ}04'$  south and longitude  $43^{\circ}14'$  and  $45^{\circ}19'$  east. The Comoros archipelago consists of four volcanic islands aligned in a southeast-northwest direction along 225 km of submarine shelf (Figure 1). These islands are from west to east of Grande Comore, Moheli, Anjouan and Mayotte. The whole archipelago covers a total surface area of 2236 km<sup>2</sup>. The Exclusive Economic Zone (EEZ) is estimated at more than 160,000 km<sup>2</sup> covering 900 km<sup>2</sup> of continental shelf and 427 km of coastline. The islands are separated from each other by a distance of about 30 to 40 km. Grande Comore is 300 km away from the coast of Mozambique and the same distance separates Mayotte from Madagascar.

Because of their volcanic origin, the islands of the Comoros archipelago are characterized by a very narrow continental shelf, with a total surface area of approximately 900 km<sup>2</sup>. Grande Comoro's continental shelf does not extend beyond two nautical miles. The narrowness of the continental shelf explains the poor development of coral reefs, especially on Grande Comoro.



**Figure 1: (a) The location of the Comoros Islands in the Western Indian Ocean. (b) The distribution of four islands the form the Union of Comoros.**

### Grande Comoro

The island of Grande Comoro is a volcanic island, 64 km long and 24 km wide, characterized by the active volcanic massif of Karthala rising to 2 360m and the older Grille massif to the north, surrounded by hundreds of ancient volcanic cones. To the south there is the M'Badjini peninsula which is also covered with cones. A coastal plain of 1 to 2km wide exists on the west coast but is absent in the south and east. The coastal and marine environment is very rich and varied with fringing coral reefs, mangroves, seagrass beds, beaches of black, red and white sand, lava flows, islets and submarine banks. There are also upwelling areas with large pelagic species. Despite high rainfall which varies according to altitude and wind exposure, the island has no permanent river systems and is also disadvantaged by a porous basaltic substrate. Infiltrating water is collected in the water table which is deep and therefore difficult to access. Coastal waters are often brackish due to salt water intrusion. The island's fresh water supply comes from basalt tanks of which the maintenance is often inadequate.

The environment's natural fragility and the limited availability or lack of some resources like freshwater resources are some of the most important features to consider while analysing the island's coastal profile. This fragility is largely threatened by the negative impacts of development. The unique underwater morphology, the strong currents and the narrowness of the continental shelf means that the immediate coastal perimeter of the island remains fragile and threatened by both natural elements (erosion, volcanic eruptions, and cyclones) and human exploitation. This coastal area is characterized by a high biodiversity in its various coastal ecosystems (coral reefs, seagrass beds, mangroves, etc.), is threatened by overfishing and habitat destruction by pollution and the exploitation of corals and beach sand.



**Anjouan**

The island of Anjouan is one of four islands of the Comoros archipelago located in the Mozambique Channel, 300 km between Madagascar and the East African coast (Figure 1). The relief is very mountainous and rises to 1 595m just 7km from the coastline (Battistini and Vérin, 1989). The coastline consists of three coastal fronts: the Bay of Anjouan, the south-west coast and the east coast. These are respectively separated by three peninsulas: Jimilimé in the north, Sima in the west and Nioumakélé in the south. 80% of this coastline is bordered by a fringing coral reef. Coral sand, basaltic, mixed or muddy sand beaches were established on small sections of reef or alluvial coastal plains.

**Mohéli**

Mohéli is the lowest lying island of the archipelago, rising to only 790m. Its terrain is rugged with deeply incised valleys, carved by numerous small rivers. It is bordered by a coral plateau of 10 to 60m deep and to the south, the eight mountainous Nioumachoi Islets can be found.

## 2. The coastal zone

### The coastline

The rocky Comorian coasts are formed of basaltic rock altered by marine and coastal erosion. They are often under water at high tide or sometimes form cliffs. On Grande Comore, the rocky shores are indented and difficult to access. They run from Simamboini, the south-western tip to the north-western tip of Djomani and are riddled with caves and caverns. On the north-eastern coast, as on Mohéli and Anjouan, these are small and often alternate with beaches. The rocky shores are generally well preserved. They are very good at protecting the coast against erosion and shelter a diversity of plant and animal species. The rocky shores are often used by fishermen as fishing bases. Fauna populations (crabs, fish) are caught to use as bait by traditional fishermen. Shellfish (nerites, periwinkles) are reputed to have medicinal properties against diseases related to malnutrition. A possible threat is overfishing of the crabs and small fish as bait for pelagic fish.

### Islets and coral banks

In the Comoros, there are 10 islets and a coral bank called «banc Vailloux». The Comoros islets are surrounded by coral sand beaches and are teeming with a wealth of marine life and terrestrial flora. The beaches of the islands are all sea turtle nesting sites. The «banc Vailloux» is a coral structure dotted with caves along its slopes where large sea fans and sponges can be found among the corals, especially among the tabular type. Most of the Comoros islets are located south of Mohéli. The island has eight islets all concentrated around the village of Nioumachouoi (Mohéli Marine Park area). These are the islets of Ouenefou, Méa, Candzoni, Dzaha, Magnougni, M'foro, M'bougo and Chandzi. An islet called 'Selle Islet' is located at the western end of Anjouan, near the village of Bimbini. As for Grande Comoro, Turtle islet is located 300m from the north-western coast near the village of N'droudé. The 'banc Vailloux' is 12 nautical miles from Iconi. This site is 3km long (from north to south) and 1.5km wide (from east to west). It is a vast offshore reef structure reaching up to between 7 and 18m below the surface.

The marine fauna and corals surrounding the islets are degraded. The Nioumachouoi reef islets which were in a satisfactory state of conservation in 1995 (less than 40% of dead coral) are now degraded with over 65% of dead coral. It has become very rare to see turtles coming to nest on Grande Comoro's Turtle islet. Only Anjouan's Selle islet enjoys natural protection because it is far from the coast. On «banc Vailloux», the impact of dynamite fishing and mooring anchors ripped off many corals. Near the bottom there are still large groupers, sharks, barracudas and stingrays.

The Comoros islets are vital elements of the country's natural heritage. The creation of the Mohéli Marine Park was justified by the need to conserve these islets and the turtle nesting sites. In addition, the islets are important assets for seaside tourism development. The «banc Vailloux» is a mecca for scuba diving and an ideal place for fishing with motorized boats. This beautiful site off Grande Comoro is a natural biological reserve.

### Coral reefs

The Comorian coral reefs are fringing reefs which constitute a narrow platform that only extends a short distance from the coast and has no lagoon. As a true barometer of the marine ecosystem's health, they play a role in protecting the coast against erosion, providing sediment supply to beaches, providing habitat for countless species which make up most of the food resources of traditional Comorian fishermen and have great potential for tourism development. From a biological perspective, the Comorian corals are characterized by a dominance of branching and tabular colonies (*Acropora*, *Pocillopora* and *Pavona* genera), massive colonies (*Favia* and *Porites* genera) as well as encrusting and foliaceous colonies (*Montipora* and *Turbinaria* genera). The Comorian reefs occupy about 60% of Grande Comoro's coast, 80% of the Anjouan coast and 100% of Mohéli's coast. Around Grande Comoro, the absence of a continental shelf explains the weak reef development. Coral reefs are highly productive ecosystems. They provide a habitat for many small fish, ensuring their food and reproduction. Thus fishing here supports over 7 500 fishermen in traditional boats. They are also a strong attraction for seaside tourism in the north of Grande Comoro and on Mohéli. Their medical and biotechnology potential are valued in other tropical countries.

Currently, the Comorian coral reefs consist of 60% dead coral and 40% live coral. In some sites, the proportion of dead coral reaches between 80 and 90%. For several years now coral bleaching has been observed, probably due to seawater temperature increase causing the death of the symbiotic algae and in time, that of the corals.

Over 50% of corals are currently affected by this phenomenon. The major pressures faced by the Comorian coral reefs are: the use of dynamite as a fishing technique that destroys the surrounding ecosystem, reef destruction by uncontrolled anchorage that have destroyed most of the reef near Moroni's harbour, walking on the coral at low tide in search of fish and octopus trapped by the tides, global warming observed in all oceans, moreover confirmed by individual observations and diving computer records highlighting an increase of 1 to 1.5°C from 1995 to 2000, fishing pressure exerted by the fishermen on the reef fringe at Galawa, the dumping of garbage directly into the sea and terrigenous deposits linked to land erosion. The difficulty of access and the low number of scuba divers still protects the black coral from harmful exploitation. A national reef network led by the AIDE NGO ensures the continuous monitoring of the reefs.

### Seagrass beds

The most common seagrass flora species in Comoros are *Cymodocea ciliata*, and the following genera; *Cymodocea*, *Glacilaria*, *Jania*, *Padina*, *Sargassum*, *Zostera*, *Porolithon*, *Ulva*, *Codium*, and *Halimeda*. Fauna settlement is marked by the presence of marine turtles, occasional dugongs, herbivorous fish (surgeonfish, damselfish, emperors, Lethrinidae), gastropods, crustaceans and others. The terrigenous deposits and discharge of wastewater and rivers promote the growth of seagrass beds and can cause an imbalance in the ecosystem as observed in Anjouan. Around Anjouan, seagrass beds are mainly located at river mouths and at Bimbini; around Mohéli they are found along the southern shores (Nioumachoua - Itsamia). As for Grande Comoro, the seagrass beds are found mainly in the Mitsamihouli Ndroudé region in the north and south from Malé to Chindini. Seagrass beds are expanding around Anjouan but are static or even declining around Mohéli and Grande Comoro. In the first case, the terrigenous deposits from the freshwater streams and erosion are the main cause. In the second case, the decline could be explained by an imbalance of the coastal ecosystem due to coral degrading and sand mining.

### General description of the climate

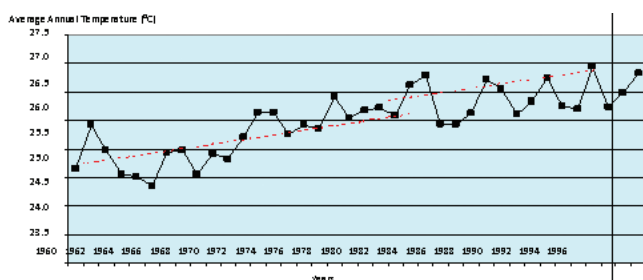
The Comorian archipelago climate is tropical maritime. It is characterized by low annual daily temperature variations around 26°C at sea level and heavy rainfall of around 2679 mm per year. The average seawater temperature is 25°C. The country is influenced successively by the South/South-East trade winds from April to November, bringing relatively cool and dry tropical air from May to October, or by the North/North-West monsoon that prevails from December to March, bringing hot and humid equatorial air from November to April. During this period the archipelago lies within or is adjacent to the inter-tropical low pressure systems. The monsoon wind speeds can reach 110 km/s in Moroni, the capital. The trade winds from the South are the most common, sometimes blowing fiercely. On the other hand, the trade winds from the East are restricted by the Madagascar relief. Wind speeds recorded at the Hahaya station can reach bursts of 75 km/s. These winds sometimes take on the characteristics of a hurricane. The annual amplitude of the average temperature is quite modest, about 4°C with a significant variation in relative humidity (Dronchon, 1982). The two seasons do not follow suddenly on each other, but are separated by transitional periods characterized by a continuous and relatively rapid evolution of some climatic parameters.

The rainy season from mid-November to mid-April is characterized by high humidity, high temperature and frequent thunderstorms, especially in January and February. The climate is also characterized by significant local variations in temperature and precipitation depending on altitude, topography and exposure. The annual rainfall varies accordingly from 1000 to 6000mm and the absolute minimum temperature reaches 0°C at the summit of Karthala. This is due to the presence of tropical depressions near the archipelago or by the passage of an «intertropical convergence front». The North-West monsoon winds usually bring warm and moist air causing high rainfall in the archipelago.

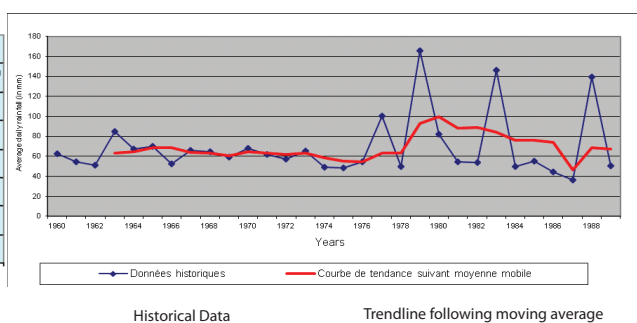
In coastal areas, the average temperature is around 27°C. The maximum temperature varies between 31 and 35°C and minimum of 23°C. During the rainy season, the Comoros islands can be the scene of tropical cyclones. Between 1911 and 1961, the archipelago experienced 23 cyclones, an average of a cyclone after every two years. Some of the cyclones are formed in the ocean, north of the 15th parallel while others are formed in the Mozambican Channel, but these generally decrease in intensity as they move north. On the contrary, cyclones become more active and intense if they move to the South. Finally, but very rarely, cyclogenesis can develop in the immediate vicinity of the archipelago with roughly a similar impact on all four islands.

The cool dry season occurs from early June to late September. It is characterized by relatively lower humidity, lower temperatures and the near-permanent winds, whether trade winds or sea breezes. At low altitude, the average temperatures are in the range of 23 to 24°C. The maximum is around 28°C and the minimum range 18 to 19°C. In some of the south and south-western facing coastlines of the islands, rainfall is abundant in June and July, but decreases significantly in August and September. The average wind speed is significantly higher than in the rainy season, with a large predominance of South/South-West trade winds. However, in the absence of cyclonic activity, there is little or no risk of storm winds.

The data on long-term changes in average annual temperature and rainfall shows that these have been increasing since 1960s due to climate change (Figures 2 and 3). According to the National Communication on Climate Change, the Union of Comoros contributes minimally to emissions of greenhouse gases (2.3 teq CO<sub>2</sub>/hab/yr). However, the country is much more threatened by the impacts of climate change. The predicted impacts are a reduction in agricultural and fisheries production, loss of biodiversity, displacement of more than 10% of the population living along the coastal zone, contamination of groundwater aquifers along the coast by sea water, and an increase in the prevalence of malaria.



**Figure 2: Annual air temperature trends in Comoros in the period between 1960 and 1989.**



**Figure 3: Rainfall trend in Comoros in the period between 1960 and 1989. (Source: national network of weather stations).**

## Marine and Coastal Geology and Geomorphology

The Comoros have been created as a result of the formation of the rift that separated Madagascar from Africa at the beginning of the Tertiary period. Tertiary volcanism gave rise to various islands in the Indian Ocean from a plateau which is a remnant of an ancient basement complex. However, the Comoros archipelago lies on the continental shelf margin. Islands, all of volcanic origin, emerged during the Tertiary period (Mayotte, Moheli and Anjouan) and Quaternary period (Grande Comore). The four islands originate from a hot spot, with an increase of the age of the volcanic formations from west to east. Although all islands are of volcanic origin, Comoros has morphological characteristics and soil types that vary depending on the age of volcanism. The island of Grande Comore consists of two shield volcanoes, one of which has gone through several phases of activity during the twentieth century (Karthala). Its morphological characteristics are very young. However, Moheli and Anjouan have reached a more advanced stage of maturation and are deeply eroded. Mayotte on the other hand has a more advanced stage of development still characterized by erosion and intense weathering. As a result its morphology exhibits a very jagged coast - a sign of active subsidence. The development of coral reefs around these islands confirms the pattern of progression of age of volcanic formations from west to east: the edge of the Grande Comore is bordered by a few embryonic fringing reefs while a more developed fringing reef almost completely surrounds Moheli and Anjouan, and there is a continuous barrier reef, delimiting a lagoon of over 12 km at its widest point, around Mayotte. Geochronological studies confirm the morphological evidence and the degree of evolution of volcanism: the rock samples studied show an age that is between 130,000 and 200,000 years for the island of Grande Comore, 5 million years (Ma) for Moheli, 3.9 Ma for Anjouan, and 7.7 Ma for Mayotte.

## **Freshwater resources and drainage, including rivers, estuaries, deltas and coastal lakes**

There are no permanent water systems in Grande Comore because of the high permeability of the soils. The drainage density was however originally dense in Anjouan, Mayotte and Moheli. However, the flow of many rivers and streams has declined sharply over the past two decades. The consequences have been a decrease in quantity and quality of available water with the resulting difficulties in the provision of water for domestic uses and irrigation. This has also meant lack of hydroelectric generation and prevalence of water-borne and vector diseases.

**Water Resources in Grande Comore:** In Grande Comore, the total absence of surface water has meant that the population depends on groundwater and cisterns systems for collecting and storing rainwater. These tanks are usually open, and poorly maintained. The city of Moroni and some localities have a system of water distribution. The quality of this water is generally safe. However all the physicochemical and microbiological parameters are not regularly analyzed. The network also is aging and its capabilities are saturated. Catchments are from groundwater which are being affected by salt water intrusion. The latter eventually forms a layer that accumulates on top of a layer of brackish water, which gradually increases in thickness. The risk of pollution of the water is high due to high soil porosity and the increase of sodium chloride concentration due to seawater intrusion. Some other water sources exist within the island. These are located in the mountains of the Grid (Bund, Suu, Hamwandzé, Mkudzi) and Mbadjini (Dzitsoni, Sadan and Suni). These vents perched water tables at high elevation and have generally low water storage rates, but provide soft water and excellent drinking water. It is also found on Grande Comore crater lakes: those at high altitude, which fill with fresh water (Lake Hatsongoma, east of Bahani), and those located near the shores, which are contaminated with salt water (such as salt lake in the north of the island).

**Water resources in Moheli:** On Moheli, rivers leave a few tens of meters of ridge lines and deep orthogonal valleys. In general, the surface drainage system is well developed and continuous except on the east and the plateau of Djandro where it is temporary. Water abstraction is carried out from these surface water sources with a booster and using hand-dug wells. Currently, 80% of the island's population has access to water through the construction of village systems of water supply. In recent years, there has been groundwater depletion in the dry season. This phenomenon is due to deforestation on the island. The M'lembéni river is the largest (7 km length, flow rate 220 l/s) and its watershed is also the largest (6.8 km<sup>2</sup> with an average slope of 14%). The forested river valley is however threatened by logging and uncontrolled clearing. There are two lakes in Moheli: Lake Dizan Boudouni covering a surface area of 30 acres south of the island, with a significant scientific interest because of its biodiversity of flora and fauna (the only Ramsar site); Lake Dziani Mlabanda near Mlabandra village, with a surface area of 2.2 ha and a depth of 1.8 m. Its waters are however turbid. The water receives no treatment and distribution system is dense but is obsolete.

**Water resources in Anjouan:** The island is characterized by a network of waterways originating from more or less permanent sources in the highlands. The wells, springs and rivers appear subject to significant seasonal variations. The majority of the population of the island is connected to a network of water supply drawn from the river catchment. But because of the reduction, low flow of perennial streams, the obsolete network and the high population growth on the island, water problems are emerging. Many water sources exist in Anjouan. However, some are permanent, while others dry up during the dry season. Catchments are important sources of water supply to nearby communities. The island has about forty semi-permanent rivers. The most important are: Tratenga, Mutsamudu, Pomoni, and Mrémani Ajao. Their valleys are narrow and deep. Two freshwater lakes exist on the island: Lake Dzilandzé, south of Mount Ntringui, with an area of 5 ha and a depth of more than 300m, and the Lake Dzia Lautsungua Drindi whose surface area is 2 ha and depth is greater than 200m.



## Physical Oceanography

### Currents (Coastal hydrodynamics and offshore current systems)

The continental slope is of limited size and slopes steeply to great depths. The Comoros Archipelago is characterized by a great richness of marine flora and fauna. The islands are influenced by many ocean currents, particularly the South Equatorial Current.

### Tidal regime and waves

Currents and tides: In the Comoros, the tides are mainly semi-diurnal type characterized by high spring tides during new and full moons (3 to 4.5m) and low neap tides during quarter moons (1m).

Waves in the Comores Archipelago can be categorised into three types: maximum normal waves due to the trade winds, long waves from southeast Africa, and exceptional waves linked to low pressure phenomena, which occur rarely. These waves can reach a maximum amplitude of 4 m with a return period of 10 years and sometimes a maximum amplitude of 5 m or more with a hundred-year return period.

### Sea level change

Comoros is facing serious problems due to climate change that is causing a rise in sea level and thus compromising its ability to implement effectively the Millennium Development Goals. The Comoros are experiencing very serious coastal erosion. Within a period of 20 years, nearly 30 to 40 m of land was eroded by the sea in many places such as Mitsamiouli in Grande Comoro, Sambia, Nioumachoi Fomboni in Mohéli, and the Ouani area near the airport, and Mirontsi and Domoni in Anjouan (Figures 4a-b). However, there are no official and reliable data sources on the extent of coastal erosion in the Comoros other than the observations made and photographs. Mapping the coast of the Comoros might provide an effective assessment of the level of erosion of the coastline due to sea level rise.



**Figures 4: (a) Coastal defence sea wall built to protect the coast against erosion and (b) erosion of the coastline threatening a road.**

In 2004, an intrusion of the sea caused the destruction of many homes on the coast bordering the villages of Pomona and Mirontsi on the island of Anjouan. A petrol station was partially destroyed. The same phenomenon caused the disappearance of a primary school in the village of Itsamia in the south of Mohéli Island. The medical clinic and the house of turtles conservation as well as 20% of homes are still threatened. On this same island, many villages are threatened and in some villages, some neighbourhoods have completely disappeared and their inhabitants were forced to move to other places. Places like Iconi and Mbachilé in the centre of Grand Comoro are threatened by the intrusion of the sea. In the village of Bangoi-Kouni, in the north of this island, the sea rose on 1 March 2006 to submerge two neighbourhoods. About twenty homes were engulfed by the sea which crossed over the seawall that was built to protect the village against the waves.

### Ocean temperature

The mean monthly temperatures of surface waters range from 26°C to 29.5°C in October–November to May and 22.8°C to 26.5°C from May to November. In 1997 and 1998 during the El Niño phenomenon in the Indian Ocean region, the sea temperature in the Comoros increased by 0.5°C for two months, leading to a change in the behaviour of marine species and ecosystems of the Comoros. A bleaching of the Comorian coral cover was recorded during this time, followed by coral death which was probably hastened by a combination of anthropogenic stress factors such as trampling of the corals, harmful fishing methods, runoff water and

household waste. The phenomenon of increasing sea water temperature was repeated in the Comoros in 2009, but was not as serious as in 1998. The regional experts studying this phenomenon under the CORDIO programme have noted that climate change/global warming is responsible for coral bleaching (Figure 5a and b).



Figure 5a-b : Coral bleaching due to global warming

### Salinity patterns

The average salinity of the seawater in the Comoros waters is 36 PSU. During the austral summer, the salinity of surface water range between 35 and 36.25 PSU while in austral winter period, it ranges between 34.75 and 34.9 PSU. The thickness of the well-mixed layer varies from 50 to 80 m depending on the season and can be changed after the passage of cyclones (30 to 100 m). The thermocline is located beyond 100 m depth. In some areas along the coastal plain, the groundwater is in contact with the sea water causing a saltwater–freshwater interface. Groundwater salinity in this interface varies with the distance from the sea. This is an indication of contamination of the groundwater aquifer by seawater intrusion and a demonstration of high vulnerability of the freshwater water resources near the coast to sea level rise. In coastal areas, tidal influence is felt more than 2 km inland. The salinity can rise from less than 2  $gl^{-1}$  to more than 6  $gl^{-1}$ .

### Ocean-atmosphere interaction

There are few studies that have been carried out on atmosphere–ocean interaction in the Comoros. However, it is important to note that Comoro experiences Cyclones. During a cyclone, winds can reach 155 km/h. On the archipelago the cyclone's impact power generally decreases as it moves from east to west. Waves associated with the cyclone reaching up to 20 meters can also be experienced. (Battistini, 1984; Bacar, 1990; Tilot, 1998). The extreme events usually observed generally involve all parts of the archipelago. These are strong winds and tropical cyclones, floods, drought and tidal waves in areas near the shore.

#### 2.5.7 Currents (coastal hydrodynamics and current offshore systems)

The Comoros are located on the path of the South Equatorial Current. This current divides into two branches: a northern branch and a southern branch, sometimes forming an eddy around the archipelago. The water of the Mozambican Channel has different physicochemical properties. During the rainy season, the current flow rate is between 1.30 and 1.45 knots. In the cooler season, this speed varies between 0.5 and 2 knots, or 0.25m/s. This surface current can be slowed down or accelerated by the prevailing winds or by the coastal and underwater morphology. Very violent currents have been observed at the western end of Anjouan Island.

## 2.6 Chemical and Biological Oceanography

The chemical and biological oceanography of the Comoros has not been thoroughly studied. However there are some data on water salinity and partial inventories of the open ocean marine fauna and flora.

### 2.6.1 Nutrients

Phytoplankton blooms have an important role in regulating the gases in the atmosphere, including CO<sub>2</sub>. Primary production by phytoplankton depends on the availability of nutrients, and as the basis of the open-ocean food chain, provides food to zooplankton, and marine herbivores. Nutrients have been studied in the waters of the Comoros, but further work is needed to understand their distribution and variability.

### 2.6.2 Persistent organic pollutants

Two types of Persistent Organic Pollutants (POPs) were reported in 2006. They were polychlorinated biphenyls (PCBs) and dioxins/furans. In the Comoros, PCBs are used as heat exchange fluids and insulators (dielectric) in electrical transformers. Dielectrics contaminated by PCBs are used in the transformers of power companies. However, their use has been banned and phased out in electrical equipment since the early 1980s in favour of mineral oils are less hazardous to health and the environment. In total there are 324 transformers spread over the three islands: 238 on Grande Comoro, 73 on Anjouan and 13 on Mohéli. The number of appliances with PCB-contaminated mineral oil is 84. The amount of transformers manufactured with PCBs represents only 6%. This is due to the fact that 90% of appliances were imported after 1990 therefore after the 1980 ban. However, the rate of mineral oil contamination appears to be considerably higher with 84% of equipment contaminated (National Implementation Plan of the Union of Comoros, PNM, 2004). The second group of identified POPs is composed of dioxins and furans, produced unintentionally during incomplete combustion or some industrial processes. Over 77% of dioxins and furans emissions come from uncontrolled combustion processes that are primarily due to the uncontrolled burning of household waste. This situation is likely to persist in the absence of sustainable solutions for waste disposal. The value of the national contribution to the global emissions of dioxins and furans in 2006 amounted to 24.196 g TEC/year. (PNM, 2004). With regard to persistent inorganic pollutants, no quantitative study has yet been made. However, it is known that this pollution consists of plastic bags, batteries, electronic waste, glass, motor oil and metals that most often end up in the sea.

The Union of Comoros, aware of the risks that chemicals in general and Persistent Organic Pollutants (POPs) in particular pose threat to human health and the environment, has ratified the Stockholm Convention on POPs in January 2007. As a signatory to the Convention, the Union of Comoros has received support from the Global Environment Fund (GEF), received technical assistance from the United Nations Institute for Training and Research (UNITAR) and the United Nations Development Programme (UNDP) for the implementation of enabling activities under the UNDP project 000-43361 at the request of the Ministry of Agriculture, Fisheries and Environment. This project aims at assisting the country to prepare National Plan of Implementation (PNM) of the Stockholm Convention, strengthen its national capacity to manage POPs and finally, maximize the commitment of the country for the implementation of the Convention.

### 2.6.3 Primary production

The Comoros are situated between the south equatorial current region and the Mozambican current region. In the south equatorial current region, changes in primary productivity are related, among others, to the seasons. During the monsoon (rainy season), primary production is relatively high with over 500 mgC/cm<sup>3</sup>/day (Kabanova, 1968). Primary production during this period is characterized by macroscopic algae: green, red and brown algae (*Turbinaria*, *Sargassum*), microscopic algae (phytoplankton) and sea grass beds. Phytoplankton production in the south equatorial current region tends to be dominated by dinoflagellates and coccolithophores, characteristic of oligotrophic waters.

The seagrass meadows are located in the lagoons between the coast and the reef flat, mostly in the south of the islands, probably due to wind patterns, rainfall which can lead to prolonged turbidity, currents and swells. The areas they occupy are limited around Grande Comoro (the north coast from Mitsamiouli to the islet of Ndroudé), but seem more important around Anjouan, particularly in the area from Bimbini to Selle islet and also around Mohéli. The seagrass flora serves as an attachment point for many organisms (algae, hydroids, bryozoans and ascidians) and a refuge for many marine species like gastropods crawling on the leaves, small



crustaceans and fish such as mullets, parrotfish, *Siganus* sp, emperors and Lethrinidae swimming among the leaves. They are also breeding, rearing and nursery areas for many marine species. However, many gaps still exist in our knowledge of seagrass beds. The primary production of the seagrasses and other epiphytic algae seems very important.

Primary production is enhanced by the phenomenon of upwelling during which underlying colder water rich in mineral nutrients (nitrogen, phosphorus and orthophosphates) is pushed to the surface. These upwellings may also locally cause coral mortality due to the thermal shock. Coral bleaching observed on the northwest coast between Ouani and Mirontsi and southwest between Sima and Moya on Anjouan, in the north on the Fomboni reef flat and south of the Nioumachoua islets on Mohéli and on the «banc Vailloux» west of Iconi and at Mitsamiouli in the north of Grand Comoro could be the result of these upwellings. This bleaching could also result from high water temperatures, soil erosion, the discharge of waste at sea, and sand and coral extraction causing physical damage.

#### 2.6.4 Secondary production

The estimated potential productivity of demersal resources of the continental shelf of the Comoros ranges from 5 to 15 kg/ha/year (450 to 1350 tons/year) and coastal pelagic zone is in the range of 10 to 30 kg/ha/year (900 to 2700 tons/year).

The Mozambique current region is characterized by a dominance of diatoms which is an ecological indicator of productive water (Cashing, 1973; Koblenz *et al.*, 1970; Key, 1973 in Tilot V, 1978). Seagrass beds provides food and are directly consumed by herbivorous marine species such as dugongs, green turtles, sea urchins and fish species *Leptoscarus*, sp, *Siganus* sp. The larvae of many epibenthic organisms and a variety of invertebrates settle on epiphytic flora, rhizomes and sea grass roots. Marine species belonging to the detritus feeders' food web feed on large amounts of detritus and organic matter coming from the sea grass beds. Thus, detritus feeders are involved in sediment reworking, the recycling of organic matter and its redistribution among the other food web compartments. Secondary production is characterized by shellfish comprising gastropods, cephalopods, arthropods, echinoderms, and bryozoans. The secondary production inventory of the Comorian ocean environment is insufficient and need to be completed and expanded to determine the actions and correct management and conservation approaches to sustain a healthy environment.

### 2.7 Coastal zone and continental shelf

Due to its volcanic origin, the Union of Comoros is characterized by is a very small continental shelf (900km<sup>2</sup>) to the west of the archipelago, the sea floor abruptly reaches great depths in excess of 3 000 m. This narrow shelf explains the weak coral reef development. The exclusive economic zone covers an area of approximately 160 000km<sup>2</sup>. Due to the diversity of habitats, the coastal and marine environment presents a diverse morphology: low-lying coasts, cliffs, islets, reef flats, etc. and nature: lava, black and white sand beaches, pebbles, boulders, coral reefs, etc. The variety encountered (mangroves, coral, reefs, beaches, seagrass beds) gives it a great wealth in terms of flora and fauna (Mirghani, 1985; Soares, 1975; Piton and Poulain, 1974; Menache, 1955-1958 in Tilot, 1998). The coastline is estimated to be 170 km long of which only a 100km is bordered by coral reefs. There are also offshore reefs on underwater peaks like 'Blanc Vailloux', located west of Iconi. This reef structure is 3 km long with a width of 1.5 km. Mangroves are also found almost everywhere in the archipelago, with a more significant development in Mohéli (91ha), reduced to 8ha on Anjouan and 18ha on Grande Comoro.

#### The main issues include the following:

- Destructive fishing techniques such as dynamite fishing, collection of fish, crustaceans and shellfish by hand or by using a cloth while walking on the reef flat, use of *Thephrosia Candida*, a plant poison, the establishment of a retention pond system at low tide, damage due to use of paddles, machetes or pitchforks, bow-nets which requires walking on the reef flat, lost stone line or bottom line on the reef flat or on the outer edge of the reef flat, etc.
- The sedimentation and siltation of the reefs by sediment deposits that smothers the corals, especially on the reef flat.
- The removal of sand and coral for construction that resulted in the disappearance of 90% of the beaches in the last 20 years on Grand Comoros.

- The high pressure of non-motorized boats (4 400 canoes) on coastal fishing.
- The high urbanization of the coastal zone resulting in coastal erosion, habitat destruction and the weakening of the coastal structure.
- Marine pollution from accidents at sea such as the Taurus boat that caught fire in March 2007 near the port of Moroni with 60 tonnes of diesel on board, the emptying of ships ballast water at sea, accidental oil spills during the transshipment of oil products in ports and oil depots. Over 30% of the world's oil production passes through the Comoros, representing more than 5 000 tanker trips per year. The accident risk increases during the cyclone season. These oil spills at sea are found on beaches in the form of bitumen balls. Similarly, pollution from (tanker) ballast water constitutes a danger to the fauna. The immediate perimeter of the Comoros remains fragile and the ecological balance is threatened by natural elements (e.g El Nino, cyclones), pollution and human exploitation, which poses a threat to the economy and the overall balance of the islands.

### 2.7.1 Description and extent of coastal and marine habitats

In **Grande Comore** : The north coast is generally low and is situated adjacent to a high marine plateau with steep banks. Within less than a mile from the coast, ocean depths reach 1 000m. The east coast has a fairly uniform appearance with few indentations and there is no coastal plain. Natural harbours and bays are rare, very small and poorly sheltered. The west coast is generally very steep and rocky, abrupt in its northern part, where however, some good sandy beaches can be found. It is low between Moroni and Saliman and very steep again in the southern part of the island (from Itsounzou to Ifoundihé).

In Anjouan : The north-western coast of the island has great depth at a short distance from the shore. Coral reef is rare and only appears towards the west (between Fouban and the island of La Selle). The east coast, high, rocky and generally steep is fringed in a few places by a narrow reef. The south-western coast is surrounded by reefs almost everywhere, which in its western part extends to nearly a mile out to sea. A few indentations of the coral reef shelter some good mooring spots with sandy beaches.

In Moheli : The smallest island is surrounded by a coral reef and a continental shelf, which is particularly wide on the south coast, where one can find a group of islands off the coast of Nioumachoua. They are included in the Mohéli Marine Park inaugurated on October 17, 2002. The north-eastern coast has an irregular reef, very close to the shore and with several indentations. These are good navigation access points to the mooring areas, not very large, but sufficiently sheltered. A few of these access points are in front of the few beaches on this coastline. The south-eastern end of the island is bordered by a reef which supports the island of M'Bouzi. From this point onwards, the south coast's predominant characteristics are developed; deep indented shoreline, alternation of bays and promontories, several beaches, a group of islands off the coast, and finally, very good areas for natural shelter.

The coastal zone of the Comoros has a rich biodiversity comprising endemic species as well as ecosystems of great ecological value. The following are most important:

**Coral Reefs.** Includes very important species of for food security and coastal livelihoods: molluscs, sea cucumbers, corals, reef fish. Also linked with the feeding areas of the hawksbill turtle (*Eretmochelys imbricata*)

**Seaweed beds.** Include target species: mollusc and sea cucumbers, but also provides important habitat for the green turtle (*Chelonia mydas*) and the Dugong (*Dugong dugon*).

**Islets.** Important for seabirds, mostly the Masked Booby (*Sula dactylatra*) Brown Noddy (*Anous stolidus*) and White-tailed Tropical bird (*Phaethon lepturus*). There is also an association with sea turtles that lay their eggs on the beaches of the islets.

**Mangroves,** taking into account their role as a breeding, refuge and nursery area for reef fish, crabs and sea/coastal birds.

**Sea turtles,** mostly green turtles nesting on the 45 beaches of the Mohéli Marine Park, but also the hawksbill turtle that occasionally nests and also feeds on the coral reefs.

**The Dugong,** very rare in the western Indian Ocean.

At least 10 **cetacean species**, including Humpback whales (*Megaptera novaeangliae*) and Spinner or Long-beaked dolphins (*Stenella longirostris*), which are seasonally abundant.



White sandy *beaches* of which most are marine turtle nesting sites

## 2.7.2 Productivity of the coastal zone (corals, mangroves, seagrass beds)

### Coral Reefs

The coral reef ecosystem is considered one of the most diverse, most complex and most productive of the marine ecosystems. It is equivalent to the rainforest on land. Coral reefs cover only 0.2% of the ocean floor, but this ecosystem supports about 25% of all marine species. Fragile and rare (coral reefs represent an area of only 284 300 km<sup>2</sup> around the world), coral reefs are first of all important fish nurseries, thus supplying fish for consumption or for aquariums. Reefs also protect coastlines from erosion by absorbing, in different cases, 70% to 90% of wave energy. Today, coral reefs are disappearing at a rapid pace. In recent decades, about 30% of the coral reefs were severely damaged. By 2030, 60% of all reefs will be threatened by pollution and, ultimately, by the acidification of the oceans due to the absorption of a large percentage of the carbon dioxide (CO<sub>2</sub>) produced by human activities.

The coral reefs of the Comoros archipelago develop along a steep volcanic shore. The reefs are fringing in nature and have developed differently in various places and in conjunction with the age of the islands, undersea features and the local hydrodynamic conditions. They occupy about 60% of the coastline of Grande Comoro, 80% of that of Anjouan and 100% of the Mohéli coastline, covering a total area of approximately 11 000ha. They offer shelter to an accompanying fauna (fish, shellfish, coral, sea fans, crustaceans) representing considerable genetic (biodiversity), economic (fisheries) and tourist (recreational diving) wealth. This ecosystem is however subject to several types of threats:

- Extraction of natural coastal materials for construction (corals, sand, pebbles),
- Certain destructive fishing techniques (dynamite fishing, plant poison such as *Tephrosia* and fishing on foot at low tide),
- Erosion of the catchment area bringing lots of sediments,
- Pollution associated with coastal urbanization (deposits of household garbage and urban waste as well as hydrocarbons),
- Business or tourism related activities (coral and shell trade/traffic), and
- Bleaching linked to the rise in seawater temperature caused by global climate change.
- The different corals families existing in the Comoros are representative of the eco-region. One can find Astrocoeniidae, Pocilloporidae, Acroporidae, Psammocoridae, Siderastreidae, Agariciidae, Fungidae, Poritidae, Faviidae, Oculinidae, Mussiidae, Pectiniidae, Caryophylliidae and Dendrophylliidae. A full inventory of the existing species in Comoros does not exist. However more than 250 species have been identified in the Mohéli Marine Park (source EUCARE, 2002).

Many species depend on the health and sustainability of the coral reefs of the Comoros (Figure 6). They are above all an extraordinary concentration of biodiversity. Indeed, they shelter thousands of species. Coral reefs are also a source of employment in the Comoros since more than 20000 people have an activity closely related to the coral reefs (Artisanal fisheries, tourism, arts and crafts).

Worldwide, the fishing potential of coral reefs is estimated at 15 tons per square kilometre per year (from 4 tons in Atoll type systems to 40 tons in Indonesian type systems). With the total reef area reaching some 600,000 km<sup>2</sup>, the global production would be 9 million tons per year. Although this represents only 12% of world fishery resources, the dependence of island populations on species associated with reefs is vital. Coral reefs alone produce 3 000 tons of reef fish per year in the Comoros; this represents a turnover of 2 billion Comorian francs per year. It is necessary to estimate the social and economic value of coral reefs in the Comoros in order to have striking arguments with which to demonstrate the importance of coral in the Comoros.

Coral reefs also play an important role in protecting the coast from wave action and cyclonic events. Seagrass beds and mangroves ecosystems are also closely associated with coral reefs. Fringing reefs, sea grass beds and mangroves also play an important role in the early life stages and growth of many species, some of which have commercial value. Moreover, they are significant in the medical field (prostheses) and pharmaceutical world. Corals are already being used for bone and dental grafts as well as in the ENT (Ear, Nose and Throat)



**Figure 7: Mangroves in Comoros**

surgical domain. In addition, studies on chemical substances produced by reef organisms to protect themselves have found that some coral species show promise in the fight against bacterial infections, leukaemia and certain cancers such as skin cancer. It is interesting to note here that science has highlighted certain aspects that are inseparable from economic interest. Finally, coral reefs are part of the culture and traditions of the Comorian population. An assessment of the health status in different locations representative of the Comoros gave the following results in 2010 (Table 1).

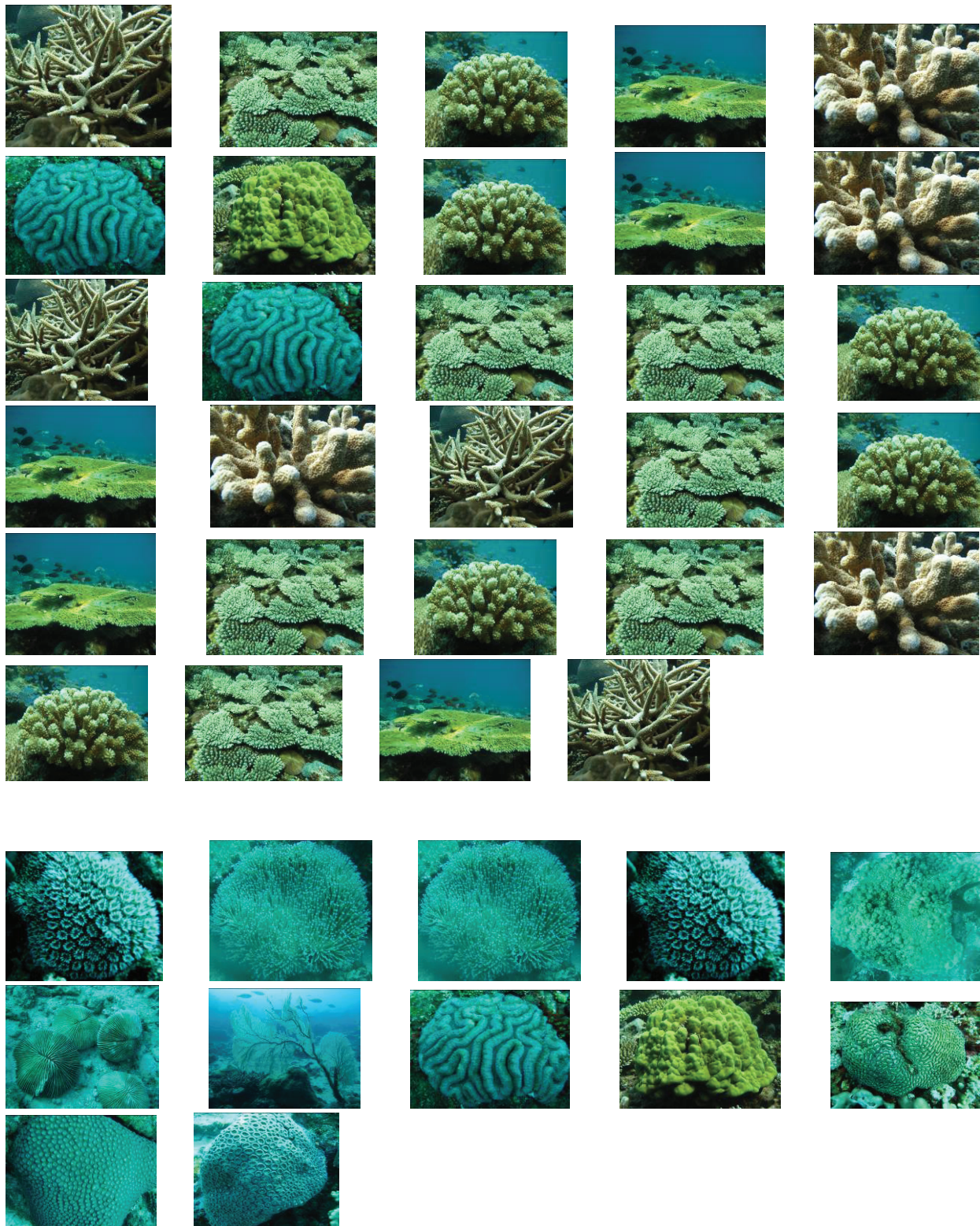


Figure 6: Several types of corals identified in Comoros (photo Fouad AR 2010)



**Table 1: Health status of coral reef ecosystem in the Comoros.**

Location	Coral Health in 2010				Investment/Action Proposals
	Alive	Dead	Bleaching	Fish Health/Count	
<b>Mohéli Marine Park</b>					
In front of Itsamia village	38%	53%	10%	High	Community management within the Marine Park
Around Mchako Rock	71%	24%	3%	High	Community management within the Marine Park
Coral reef flat in front of wallah 1	10%	90%	0%	Very low	Help the community to manage the reef
External slope in front of wallah 1	60%	30%	5%	Average	Community management
Candzoni external slope	25%	65%	5%	Low	Set aside as complete reserve plus active restoration
Candzoni Coral reef flat	15%	70%	3%	Very low	Set aside as complete reserve plus active restoration
Shoal between Candzoni and Ouénéfou	85%	10%	4%	High	Set aside as complete reserve
Entrance of the Candzoni narrows; Coral reef flat	20%	70%	4%	Low	Set aside as complete reserve
Entrance of the Candzoni narrows; external slope	43%	40%	4%	Average	Set aside as complete reserve
Around Méa Islet; external slope	35%	50%	10%	Low	Active restoration, propagation by cuttings
Around Méa Islet; Coral reef flat	15%	75%	5%	Very low	Active restoration, propagation by cuttings
Habawoussi ; Coral reef flat	65%	23%	10%	Average	Community management
Habawoussi ; external slope	70%	20%	7%	High	Community management
Around Bwé la Nkaouré Rock	75%	15%	5%	High	Community management
Around Bwé la Ngnadzi Rock	5%	85%	1%	Very low	Community management
Sambia ; Coral reef flat	75%	20%	5%	Average	Active restoration, propagation by cuttings
Sambia ; external slope	50%	45%	4%	Average	Community management
<b>Mitsamiouli Area</b>					
In front of Mitsamiouli, Coral reef flat	0%	0%; Seaweed 90%	0%	Very low	Joint management with communities
In front of Mitsamiouli, mixed reef	5%	85%	0%	Very low	Joint management with communities
In front of Mitsamiouli, external slope	85%	10%	1%	Low	Joint management with communities
In front of Maloudja (1-3m)	5%	90%	4%	Low	Joint management with communities
In front of Maloudja (7-10 m)	25%	70%	1%	Average	Joint management with communities

Location	Coral Health in 2010				Investment/Action Proposals
	Alive	Dead	Bleaching	Fish Health/Count	
In front of Maloudja (10–20m)	80%	15%	4%	Average	Joint management with communities
In front of stadium ; Coral reef flat	8%	80%	2%	Very low	Joint management with communities
In front of the stadium, external slope	35%	50%	10%	Average	Joint management with communities
In front of the 'prophet's hole'; Coral reef flat	30%	60%	5%	Low	Joint management with communities
In front of the 'prophet's hole'; external slope	85%	10%	2%	Average	Joint management with communities
In front of Galawa Hotel; Coral reef flat	40%	55%	2%	Low	Joint management with communities
In front of Galawa Hotel; external slope	55%	40%	2%	Low	Joint management with communities
In front of Fassi ; Coral reef flat	30%	60%	2%	Very low	Joint management with communities
In front of Fassi ; external slope	75%	20%	4%	Average	Joint management with communities
In front of Banguoi, Coral reef flat	35%	60%	4%	Average	Joint management with communities
In front of Banguoi; external slope	40%	55%	4%	Average	Joint management with communities
<b>Bimbini Area</b>					
Hassimpao (1–3m)	5%	90%	0%	Very low	Active restoration
Hassimpao (3-5m)	15%	75%	1%	Low	Active restoration
Hassimpao (10-20m)	35%	60%	1%	Low	Active restoration
In front of Bimbini village; Coral reef flat	5%	65%	1%	Very low	Set aside as complete reserve plus active restoration
In front of Bimbini village; slope	20%	65%; seaweed 25%	1%	Low	Set aside as complete reserve plus active restoration
Around Selle Islet, Coral reef flat	3%	90%	1%	Very low	Set aside as complete reserve plus active restoration
Around Selle Islet, slope	25%	65%	3%	Low	Set aside as complete reserve plus active restoration

## Mangroves

Mangroves are typical coastal plants, grouped in unique ecosystems, growing along protected shorelines in the intertidal zone of tropical and subtropical regions (Figure 7). Mangrove ecosystems contain more or less 60 species of trees and shrubs and around 20 associated species that are not exclusively limited to mangrove systems.

Mangroves grow well in areas supplied with fresh water and sheltered from the ocean currents, such as estuaries, lagoon systems, and shallow coastal areas. Their roots grow in anaerobic sediments and oxygen is supplied by small pores (lenticels) found on their trunks and aerial roots. Mangroves are found in bands along steep shores and coastlines, or as important forests in deltas. The mangroves are home to zones or mosaics of different biological communities based on factors such as the height of the sediment in relation to the tides, the salinity and amount of nutrients (which, in turn, are all influenced by fresh water). When it is in a very good environment, the mangrove ecosystem is extremely productive with a net productivity of 23.3 tons per hectare per year, producing up to 10 tons of detritus per hectare per year. As mangroves are influenced by fresh water and nutrients from their catchment area, they have an influence on the surrounding coastal waters and associated ecosystems such as coral reefs, sea grass beds and marshes subjected to the action of tides. They retain and stabilize sediments that otherwise would limit the growth of corals.

The mangrove waters of the Comoros are home to plankton, algae, molluscs, crustaceans and fish. Many bird species are related to the mangroves as they find food on the mudflats. The mangroves of the Comoros are also environments that are rich in mineral and organic nutrients from abundant decaying organic matter. The latter, consisting mainly of mangrove leaves, is fuel to a considerable bacterial and fungal flora, base of a vast food chain. Bacteria and fungi provide essential nutrients (amino acids, sterols) to the microscopic invertebrate animals that consume plant debris or fragments of the film on the surface of the water. The decomposing activity of the bacteria and fungi releases minerals that will be used by phytoplankton (microscopic algae in the water) via photosynthesis. The algae are then eaten by microscopic animals and invertebrates. The small debris-consuming animals are then in turn consumed by other larger animals, including juvenile fish, crabs, which find abundant food resources in the mangroves.

The mangroves of the Comoros are real nurseries. The larvae of many species of fish and shellfish take advantage of the abundant food available in this ecosystem. The water's turbidity also shields them from their predators. The mangrove roots are used by invertebrates such as oysters, tube worms (Sabellida etc) and sponges as support structures by clinging to them. The root system also acts as a refuge, not only for juveniles but also for small species, protected from predators by the tangle of mangrove roots and water turbidity. The Comoros mangroves also help with the development of off shore coral reefs by retaining the particles in suspension, the mangrove helps to clear the water and this is essential to the corals. The presence of mangroves prevents coastal erosion: the tangle and flexibility of the mangrove trees' roots decreases the water's turbulence, thus facilitating sedimentation. Some areas, such as the road going to Wallah Miréréni, are spared from the highly developed coastal erosion present on most of the park's coastline thanks to the presence of mangroves. Most of the population living around the mangroves uses mangrove wood for cooking, but also as timber for house construction. This wood is taken from the land-facing side of the mangroves, so the species that live in contact with the sand such as the Sonneratiacées and Rhizophoraceae are used first.

The seven species found in Comoros are: *Rhizophora mucronata*, *Bruguiera gymnorhiza*, *Sonneratia alba*, *Avicennia marina*, *Lumnitzera racemosa*, *Heritiera littoralis* and *Ceriops tagal* (Figures 8 and 9). They are always associated with many coastal species at the back of the mangrove areas (*Phoenix reclinata*, *Hernandia nymphaefolia*, *Hibiscus tiliaceus*, *Caesalpinia bouduc*). *Euclea mayottensis*, an associated species that is endemic to the archipelago is also common. Mangroves are home to a rich and varied birdlife such as the dimorphic egret, *Egretta dimorpha*, the grey heron *Ardea cinerea*, the great egret *Casmerodius albus*, the cattle egret *Bubulcus ibis* or the green/striated heron *Butorides striata* (Louette et al., 2008). Among these seven species, the most abundant are the *Rhizophora mucronata* and *Avicennia marina*.



*Rhizophora mucronata*

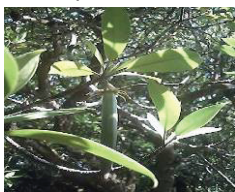
Dominant species in the Mohéli Marine Park. The *Rhizophora* type mangrove grows in the transit area between the terrestrial and marine environment, at a depth of about a feet at high tide. They have stilt roots (called «Rhizophores»): they not only allow a good anchor in soft, loose substrates like muddy soil, but also give flexibility to the plant that allows it to resist the tidal movement of ebb and flow. In addition, Rhizophoraceae have a particular way of germination: The seed germinates and the embryo develops on the tree itself. It is thus not a seed that falls from the tree, but a small seedling that is sufficiently developed so that it takes root as soon as it falls to the ground.

*Avicennia marina*



The *Avicennia* mangroves grow in swampy areas, behind the Rhizophoraceae, inside the mangrove. It is their very dense network of horizontal surface roots that allows them to find a stable anchorage in very soft, loose soil. These mangroves also have aerial roots (called «pneumatophores») that allow them to «breathe» despite prolonged periods of immersion in water.

Other species are found in very small quantities among the *Rhizophora* and *Avicennia*.



*Sonneratia alba*



*Lumnitzera racemosa*



*Heritiera littoralis*



*Ceriops tagal*



*Bruguiera gymnorhiza*

**Figure 8: Species of mangroves found in the Comoros**



**Figures 9a-b: Mangroves in Comoros, Mohéli Marine Park and Ouroveni, Comoros**

An assessment of the health of the mangroves of the Comoros in 2010 gave the results presented in Table 2 below.



**Table 2: An assessment of mangrove ecosystem health in Comoros**

Sites	Health	Recommendations
Eastern Nioumachoi	Very good	Co management with the communities to maintain health
Northern Nioumachoi	Good, but part of the mangrove destroyed by deforestation	Co management with the communities to maintain health and reforestation of 10,000 propagules
Wallah 2	Very good	Co management with the communities to maintain health
Wallah 1	Average, some deforestation taking place	Co management with the communities to maintain health
Sambia	Very small but in good health	Co management with the communities to maintain health
Bimbini, in front of the village	Threatened by waste dumping and deforestation	Co management with the communities to maintain health; domestic waste management and reforestation of 20,000 propagules
Around Selle Islet	Very good	Co management with the communities to maintain health
Ouroveni, in front of the village	Threatened	Co management with the communities to maintain health; domestic waste management and reforestation of 20,000 propagules
Ouroveni, in front of the sea	Very good	Co management with the communities to maintain health

### Seagrass beds:

Seagrass beds are highly important in the conservation of biodiversity and the physical protection of the coastal environment. The importance of these ecosystems is primarily due to their high productivity and the enormous wealth of their associated fauna. Their survival depends on maintaining the conditions of salinity, light, hydrodynamics and their relationships with associated fauna, particularly herbivores. The largest concentration of sea grass is in the Mohéli Marine Park (almost 90%), but there are also a few beds at Mitsamiouli, Malé and Ouroveni in Grande Comoro and at Bimbini and Ouani in Anjouan. In the Mohéli Marine Park, the seagrass beds have undergone a complete restructuring in the late 1990s. The high sediment influx into the lagoon from deforestation, coupled with the effects of global changes (ENSO 1994 and 1998) resulted in the disappearance of *Thalassodendron ciliatum* beds. This species previously covered all back reef depressions of the Mohéli Marine Park, leaving space for a succession of species with varied ecological preferences. Two studies by Beudard in 2003 and 2005 showed the re-colonization of these areas by pioneering multi-species seaweed, mainly *Halodule uninervis* (Figure 10). Depending on environmental and substrate conditions, there are also patches of the seagrasses *Halophila ovalis* and areas of mixed *Cymodocea* (*C. rotundata*, *C. serrulata*), *Syringodium isoetifolium* and *Thalassia hemprichii*.

The seagrass beds of the Comoros are subject to significant seasonal variations. They are strongly influenced by sedimentation due to catchment area soil erosion during the rainy season. This increases water turbidity and covers seagrasses. They are more extensive during the southern winter thanks to more favourable environmental conditions and the sediments carried by the southward flowing currents. With a high concentration of marine fauna (shellfish, juvenile fish, sea cucumbers etc), the sea grass beds of the Comoros are real meadows for dugongs and green turtles, which depend on them for survival. The dominance of *Halodule uninervis* makes the Mohéli Marine Park a refuge for the dugong's survival. Heavy grazing by turtles and dugongs tends to increase the quality of the pasture's composition and nutritional quality. The viability of this ecosystem in the Comoros is considered good.



**Figure 10: Thick *Halodule* meadow in Itsamia, Comoros (Photo: F. Beudard)**

The creation of nature reserves for sampling and business activities (professional and recreational) would be an asset to the Mohéli Marine Park for the conservation of species and their feeding grounds. In addition, the seasonality of this environment in the Mohéli Marine Park must be regularly monitored to determine its dynamics and health. Inventory data (2003) of the sea grass beds in the Mohéli Marine Park, an investigation of dugongs (2004) and some PPG (Powered Para Glider) flights (2007) all show that the areas of Itsamia, Hagnenguélé, Ndéménani and Damou are most suitable for the feeding of turtles and dugongs. Ecological sets of beaches-mangroves-sea grass beds-coral reefs are very important for the conservation of coastal areas and their resources. To preserve the good viability of coastal ecosystems in the park, management objectives are:

- To ensure the recruitment of stocks of species dependent on coral reefs.
- To maintain sea grass bed habitat for feeding dugongs and turtles.
- Establish zoning in Itsamia and Damou (Ouallah Miréréni to Miringoni), Mitsamiouli, Ouroveni and Bimbini to ensure these goals.

## 2.8 Microfauna and meiofauna

Coastal and marine fauna of the Comoros are rich and contain elements of global importance. At present, there are no studies on the Comorian microfauna and meiofauna. Research is therefore needed to understand the nature and abundance of these species.

## 2.9 Macrofauna

The marine environment of the Comoros is characterized by a varied fauna of demersal fish, crustaceans and shellfish living on or near the sea bottom and pelagic coastal species living in shoals of varying density according to the seasons. According to preliminary investigations and estimates, coastal and marine biodiversity of the Comoros is abundant and diverse with elements of global importance.

Almost 820 marine fish species (coastal and pelagic combined) exists in the Comoros. A brief inventory of the flora and fauna found eight phyla, including 24 classes and 114 genera. The fish of the coastal and marine environment of the island of Grande Comore are relatively numerous and diverse. The inventory of the fish further revealed 24 different orders, 89 families and 485 species (that is to say a little more than half of the total estimate of the number of fish species in Comoros).

The marine environment is also home to marine mammals (dolphins, dugong, whales, etc.). There are 12 whale species in the Comorian waters including *Megaptera novaengliae*, *Eubalaena australis* and *Balaenoptera Edena*. The dolphin species include *Sousa chinensis* (humpback dolphin), *Stenella longirostris* (spinner dolphin), *Tursiops truncatus* (bottlenose dolphin) and *Delphinus delphis* (common dolphin). Dolphins and whales are observed in the west to the south of Grande Comoro between Chindini and Itsandra, to the southwest of Anjouan between Pomona and Moya and in Mohéli they are found on the vicinity of National Marine Park of Mohéli to the

south of the island.

There are probably other species of Comorian macrofauna not yet identified. The Comorian marine flora and fauna are threatened by various types of pollution (waste, hydrocarbons, soil erosion, sand and coral extraction, human activities, upwelling, etc.). It is therefore necessary to establish monitoring systems for pollution, reef health and weather conditions and systems to assess the impact of human activities as well as an inventory of fauna and flora species within reef ecosystems.

### 2.9.1 Invertebrates

#### Crabs

The coconut crab *Birgus latro* is the largest terrestrial invertebrate living in the Comoros. It is also the largest land crab in the world (up to 3 kg). It lives in large burrows in the soft substrate at the seaside. It feeds on cracked coconuts or other organic waste. Its eggs are deposited in sea water and the larvae spend the early stages of their lives there before becoming terrestrial. It is found on almost all Indian Ocean islands and it is captured by fishermen to use as bait for fishing traditional coastal fish (mullet, parrot fish, triggerfish). The main cause of its scarcity is related to its overexploitation as bait for traditional fishing. The species is protected under Appendix II of the Nairobi Convention.

#### Marine molluscs

The protected and endangered marine shellfish in the Comoros include *Choriona tritonis*, *Cipraecassis rufa*, *Cassis cornuta*, *Lambis* sp., *Turbo marmorato*, *Tridacna squamosa*, *Tridacna maxima*, *Hippopus hippopus* and *Pinctada* spp. Only one species, the *Chiton comorensis*, is known to be endemic to the Comoros. Some species are cosmopolitan while others are confined to specific environments. These shellfish find shelter on the coral reefs and the rocky seabed of the archipelago's coastal waters. The richest areas have not yet been properly surveyed, but molluscs seem to be abundant in the most preserved areas such as Beit Salam at Itsandra on Grande Comoro and Mea islet off Mohéli. In fact, certain molluscs like the *Charonia tritonis*, are rare and have an important ecological role as they are starfish predators (which in turn are coral predators). Their collection can thus lead to the proliferation of *Acanthaster* and therefore the coral reefs' ecological imbalance. Many tons of these shells are exported to neighbouring countries (Madagascar, Kenya and Tanzania). The short term economic interest is increased revenue for the collectors and enrichment of the exporters. Shellfish exploitation is carried out in part by exporters that have collection agents posted in different parts of the islands and also by young people from the coastal villages that supply tourism points of sale. It is difficult to get an accurate quantitative evaluation of shellfish harvest in the Comoros. However all the places more or less frequented by tourists offer shellfish for sale and the airport control service regularly finds stocks in the luggage of boarding passengers. Licences are regularly given to exporters without any real control over the quantities and species exported. This allows us to assume that the over-exploitation of these molluscs is reflected in their rarity. Placing the Nioumachoi islets south of Mohéli in a reserve would allow strict control of the mining and removal of materials or marine and coastal animals. A ministerial decree No. 02/015 of March 1992 prohibits the collection of shells, coral mining and the capture of turtles and their marketing (Annex II to the Nairobi Convention, Article 43 of the Framework Law on the Environment and the protection of Category 2 species).

#### Octopus

The Octopus or «*Npouédza*» in Comorian is a mollusc of the *Octopus* genera. The sites known for their abundance are Mitsamiouli, Chindini, Malé (Grande Comoro), the Nioumachouoi islets, Wallah, Itsamia (Mohéli), Pomoni, Moya and Ouani (Anjouan). They are over-exploited because they are vulnerable and easily accessible without owning a canoe. Octopus consumers are also quite numerous in the Comoros. Hunting for octopus is done by walking on the reef flat at low tide. Fishermen, especially young people and women, catch octopus trapped by the tides. The most common technique is to break the coral (octopus's home) with a harpoon. On Mohéli, another technique of which the health and environmental effects are not yet known, is to spread lime in the octopuses' habitat; they exit blinded and paralyzed. Octopus consumption in the Comoros is encouraged by their low prices compared to that of fish. However, for many people, the consumption of octopus is taboo, probably caused by food allergies associated with their consumption. There are no specific regulations for the protection of octopus in the Comoros, although this species is currently overexploited. It is urgent to limit their exploitation and to prohibit the use of harpoons and lime as methods of capture.

## Sea cucumbers

Holothurians or sea cucumbers («*chipapa kodjo*» in Comorian) are animals of the Echinodermata phylum and are found in many marine habitats, from the intertidal zone to large depths. In the Comoros, sea cucumbers are not particularly abundant in comparison to neighbouring countries such as Madagascar. The morphology of most of the Comorian reefs is very abrupt and steep and is not favourable to sea cucumbers which are characteristic of reef or reef associated habitats (seagrass beds, sandy sea beds). The outer slopes and channels are colonized by *Holothuria nobilis*, *H. excellens*, *H. edulis*, *Thelenota ananas*, *Bobadschia argus* and *H. Fuscogilva*. *Actinopyga miliaris*, *H. atra*, *H. coluber* and *H. leucospilota* are found on the inner reef flats while *H. cineracens*, *H. impatiens*, *A. mauritiana*, *A. Echinites* and *Stichopus variegatus* are found on the outer reef flats. The outer lagoon is colonized by *B. maculisparsa*, *B. marmorata* and *H. fuscopunctata*. *H. scabra*, *B. vitiensis*, *B. similis* and *H. flavomaculata* are found in the bays (mangroves). Although their use is not developed in the Comoros, potential threats still exist regarding the harvesting of sea cucumbers for commercial purposes, as is the case in Madagascar. Recently, Malagasy have asked the Environment Directorate General for the permission to exploit sea cucumbers in the Comoros. Currently, the Comorian sea cucumbers are not subject to any exploitation. A Comorian contractor tried to exploit sea cucumbers in 1998, but ceased this activity, not by order of the Production and Environment Ministry, but following an accident that killed two of their divers. Currently, no formal legislation in force or management action protects this species group. However, following an awareness session on the importance of these species in the Biodiversity project's context, informal management for their protection is carried out in the communities or villages. In 1998, a Malagasy obtained permission to exploit sea cucumbers around the islets of Nioumachoi. Thanks to the pressure and the refusal of local associations, he could not continue this activity. However, it should be noted that covert operations are developing around sea cucumber exploitation through Malagasy and Chinese networks.

## Crustaceans

The most frequent species in the Comoros are crayfish, mantis shrimps, hermit crabs and crabs. Several species of crayfish live in the Comorian reefs: *Palinurus japonicus*, *P. ornatus*, *P. versicolor* and *P. longipes*. The latter is the most coveted and most exploited species in the Comoros. Crayfish are found mainly on the outer slopes of the coral reefs, often sheltered at the base of big corals such as Porites. They tend to go up to the reef flats at night where they become easy prey for fishermen. Crayfish are found on almost every Comorian reef. According to fishermen, they are found easily on Grande Comoro at Itsandra, Ouroveni, Malé, Mitsamiouli and Itsoundzou. On Mohéli they are especially found on the Nioumachouoi islets, at Itsamia and at Wallah. On Anjouan, they are found at Moya, Pomona and Ouani. Crayfish are not currently under threat of overexploitation in the Comoros. However there is reasonable pressure on the resource. It is conceivable that future tourism growth in the Comoros will greatly increase fishing pressure on crayfish. The few crayfish caught by fishermen are quickly sold to foreign residents and hotels. Their price is four times higher than that of fish and represents a significant income source for the fishermen who catch them. The existing legislation for the protection of marine species does not mention crayfish protection. However, the protection of the Comorian coral reefs obviously leads to the protection of associated crayfish. Moreover, the fact that crayfish is not part of the Comorian cultural diet is in itself a partial measure of conservation and protection. A more comprehensive and thorough inventory of marine resources is essential.

### 2.9.2 Fish and fish resources

#### The inshore fish:

The coastal fish biodiversity of the Comoros is low compared to other countries in the region due to the absence of a continental shelf. There are about 820 species of coastal fishes. Due to overexploitation, it is now very rare to find jacks, big groupers and parrot fishes in the reefs of Grande Comore. These are over-exploited by traditional fishing using galawa (traditional outrigger boats), but mostly by the massive use of dynamite and Tephrosia (plant poison that paralyzes and kills fish) and the use of small mesh nets.

#### Deep-sea fish

Deep-sea fish are most diverse and they constitute the bulk of catches in the Comoros. In 1991 (FAO statistics), the estimated catch was 6,500 tonnes of pelagic fish. In 1995 (Statistics Directorate of Fisheries in the Comoros) the catches were 13,000 tonnes. The catches of tuna amounts to 20,000 tonnes per year, fished mainly in



the EEZ of the Comoros by EU foreign vessels in fishing agreements with Comoros. Comorian waters can no longer support a fishery of up to 40,000 tonnes per year of deep-sea fish species without compromising the ability of the species to regenerate. Offshore pelagic fish most caught in the Comoros are the sailfish (*Istiophorus platypterus*), blue marlin (*Makaira Mazara*), king mackerel (*Acanthocybium solandri*), the skipjack tuna (*Katsuwonus pelamis*), yellowfin tuna (*Thunnus albacares*), bigeye tuna (*Thunnus obesus*), the rainbow runner (*Elagatis bipinnulata*) and mackerel (*Selar crumenophthalmus*).

### **Industrial and semi-industrial fishing**

In 2011, the Government of Comoros signed an agreement for the establishment of an industrial fishing company in the country. The infrastructure of this company is still being developed with the intention of reaping fisheries revenue for the Comoros through exports of fish products. Before this project, in the framework of fishing agreements with the European Union (Lomé Agreements, the Cotonou Agreement), the focus was to offer support programs to fishermen to increase production and establish cold storage facilities for fish preservation. These programs, implemented by the government with the support of development partners (European Development Fund, Japan), have promoted a more professional approach in the artisanal fishery. At the moment, the degree of motorisation is increasing being 30% of a fleet of 5000 boats. The support the country has received has also induced an increase in domestic fish production that increased from 6000 tonnes in 1985 to 16,200 tonnes in 2004, resulting in the cessation of fish imports into the country.

### **International support and cooperation in the field of fisheries**

The fisheries sector has experienced substantial technical assistance from 1981 to 1995: five major projects were implemented: Japanese projects (3 JICA projects from 1981 to 1989), the African Development Bank project (ADB from 1982 to 1985), the FAO projects (1986 and 1987), EDF's artisanal fisheries projects (1987-1993) and the "Tuna Assistance" project financed by EDF (1988 to 1995). Since 1995, virtually no foreign aid was injected into the fisheries sector. It was only after 2002 when the FAO started a TCP whose goal was to redesign the legal framework and definition of an operational strategy for fisheries management (TCP/COI/2902). The World Bank's through the Emergency Credit for Economic Recovery (CURE) programme (until 31/12/2002) assisted with the installation of marine safety equipment in all the three islands.

## **2.9.3 Mammals**

### **Dolphins and Whales**

In the waters of the Comoros archipelago, the following dolphin species can be found: *Sousa chinensis* (humpback dolphin), *Stenella longirostris* (spinner dolphin), *Tursiops truncatus* (bottlenose dolphin) and *Delphinus delphis* (common dolphin). Whales are also cetaceans and include, in addition to some odontocetes, species with baleens or mysticetes. This group of species is not well known in the Comoros. The data available in Mayotte indicate the presence of at least 12 species of whales in Comorian waters, including the humpback whale (*Megaptera novaengliae*). *Eubalaena australis* and *Balaenoptera edena* are also encountered quite often. All these species are protected by the international CITES convention. Dolphins usually live offshore, but regularly come to the coast to catch sardines. They are gregarious and their social organization is highly developed. They communicate and locate themselves and their prey using ultrasound. Whales also live offshore as well as close to the coast. Despite their size, they feed mostly on tiny prey, planktonic crustaceans or zooplankton. Whales and dolphins are found in the waters southwest of Grande Comoro between Itsandra and Chindini, southwest of Anjouan, off Pomona and Moya, and on Mohéli, around the Nioumachouoi islets. The largest concentration of dolphins is located at Itsoundzou on Grande Comoro; also called the Bay of Dolphins. They are generally abundant from September to December.

In the Comoros dolphins and whales are not subject to any threat. The animals are also greatly feared by fishermen. However, offshore threats remain. European vessels authorized to fish in the Comorian EEZ are not controlled and it is a known fact that the trawlers regularly catch dolphins in their nets. An eventual fisheries agreement with Japan must absolutely take into account the protection of dolphins and whales. Currently in the Comoros, dolphins and whales are not subject to any commercial activity, even for tourism. No law or regulation regarding the protection of whales and dolphins exists in the Comoros. However, in 1994, the International Whaling Commission (IWC) decided to create a whale sanctuary in the Indian Ocean, but to date this has not been implemented. In September 2000, two inventory missions of Humpback whales and other cetaceans were

undertaken in the Comorian territorial and EEZ waters as part of a regional cooperation program in association with the Megaptera NGO of Mayotte. These missions performed skin biopsies and photo identification with the aim to study the genetic population structure and establish a population catalogue of the whales frequenting the Comoros. Cetaceans are abundant in Comorian waters with more than 10 species (Figures 11 and 12). The most common dolphin is the long-snouted or spinner dolphin (*Stenella longirostris*), the bottlenose dolphin (*Tursiops truncatus*), the common dolphin (*Delphinus delphis*) and the Indo-Pacific humpback dolphin (*Sousa chinensis*). Three whale species are also found: the humpback whale (*Megaptera novaeangliae*), the southern right whale (*Eubalaena australis*) and the Bryde's whale (*Balaenoptera eden*). Four large sperm whale pairs (*Physeter macrocephalus*) were observed in March 2009, off the coast of Itsamia.



**Figure 11: Spinner Dolphin *Stenella longirostris* (Itsamia, Photo: F. Beudard)**

The humpback whale, the most common and most spectacular marine mammal is present in large numbers from July to November during the mating and calving season after a long migration from the polar waters of Antarctica. The warm and shallow waters of the Mohéli Marine Park are the most favourable in the Comoros during this period of migration of humpback whales. The Indian Ocean is a whale sanctuary since 1979. They are protected internationally. The Union of Comoros is a member of the Whaling Convention. In the Comoros, the IUCN has classified humpback population as of minor concern. However, to ensure a sustainable eco-tourism, it is important to monitor tourism activity to avoid disturbing the animals.



**Figure 12: *Megaptera novaeangliae* calf at Nioumachoi Islets, Comoros (photo: F. Beudard)**

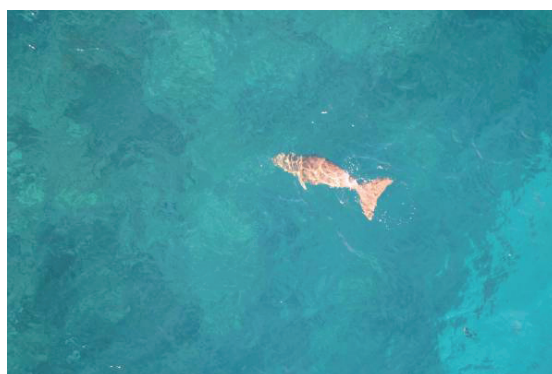
### Dugongs

The dugong is a large marine mammal belonging to the Sirenia order. It is devoid of aggression, which makes it extremely vulnerable. It is a declining, but also a very elusive species and it is therefore difficult to make populations estimates or to monitor trends. They are generally observed between August and October. The dugong's preferred habitat is a coastal lagoon where the coral provides shelter against turbulent offshore conditions and where the sandy bottom allows the development of seagrass beds. Dugongs feed on seagrass beds, preferably at a shallow depth (1-12m) along the coast (at temperatures between 20 and 30°C). Recent investigations by a Biodiversity Project team revealed that dugongs were observed in 1994 and 2000 along



Mohéli's south coast, where seagrass beds are found. According to investigations by Tilot (1994) in Mohéli, evidence has shown that in 1987-1988 dugongs were caught at Mirereni, in 1990 at Mbatsé and at Hoani in 1982. Other dugongs were observed in September and October 1993 and two were seen at Domoni in January 1994. In Grande Comoro two individuals were observed in 1987 in the area of Mitsamiouli. Dugong meat is very popular which makes them a target species for net fishing by the Mohéli fishermen. Their presence in the Comoros has a heritage interest which is important to preserve. Overfishing and degradation of seagrass beds are the main threats to dugongs in the Comoros. Dugongs are protected by legislation, including Annexes I and II of CITES, classified as a vulnerable species in the IUCN Red List, Annex II and IV in the Nairobi Convention placing the Mohéli seagrass beds in reserve as part of the Mohéli Marine Park establishment, Article 41 of the Environment Framework Law concerning the protection of Category 1 species.

Once approaching a population of several hundred individuals in the waters of the Mohéli Marine Park, the dugong (*Dugong dugon*) or «ngouva» in Shicomori is still regularly observed, but in small numbers (Figure 13). This marine mammal, the only representative of the Dugongidae family in the Sirenia order, feeds mainly on *Halodule uninervis* and *Halophila ovalis*, that are widespread in the coastal waters of the Mohéli marine park (Beudard, 2003). This herbivore was subjected to intensive hunting during the 30 years preceding the creation of the protected area. In good conditions this fragile species, calves only after every five years. The number of dugongs was very small before the creation of the marine park because of hunting with nets. However, a few are still in the park and some calves were spotted recently. The main dugong sites are located in the islets of Nioumachoi and in the entire marine area of Itsamia. Two surveys conducted in 2004 and 2006 among fishermen in the marine park (109 in 2004 and 97 in 2006) have numbered 9, 13 and 13 sightings, respectively in 2003, 2004 and 2006. Areas ranging from Hamavouna to Hagnamoida and from Miringoni to Ouallah 2, areas also colonized by sea grass beds, are the sites of the most frequent observations. Recent observations from aerial surveys in March and September 2007 have allowed the identification of two distinct individuals in the area of Itsamia (Beudard *et al.*, 2008). In November 2007, a fisherman from this area claims to have seen a mother and her calf.



Figures 13 a-b: Dugong at Itsamia, Comoros

#### 2.9.4 Reptiles

Twenty-five species of terrestrial reptiles have been recorded – mainly species of snakes and lizards. Eleven species are endemic, including five species of geckos, two species of chameleons, three species of snakes and one species of skink.

##### Marine turtles

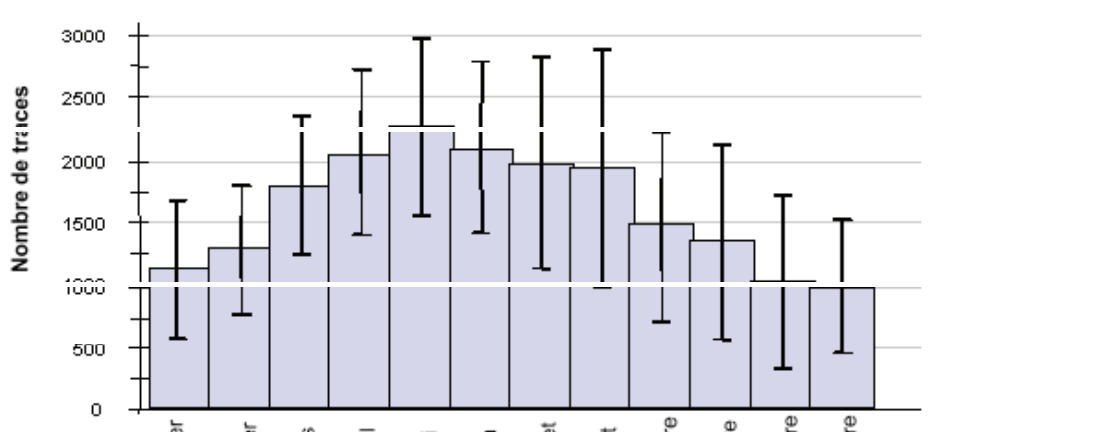
Sea turtles are among the endangered species protected by CITES. The Comorian waters are frequented by four species of turtles among the seven recognized species of the world: These are green turtle (*Chelonia mydas*), hawksbill turtle (*Eretmochelys imbricata*), loggerhead turtle (*Caretta caretta*), and leatherback turtle (*Dermochelys coriacea*). Two species are endangered (green turtles and hawksbill turtles) and nest on the Mohéli beaches.

On Grande Comoro, turtles are found in the coastal waters, but only the Malé, Mbashilé, Maludja and Ipvwani beaches show rare signs of nesting. Turtle Island “shissiwa Ndrudé sha” which is 300m from the north-east

coast is home to turtles in the seagrass beds and surrounding waters, but nesting is rare because of the disappearance of the sand and due to human activities. On Anjouan there are no nesting sites because of poaching and sand mining. Some nesting traces are found on the Bimbini, Moya and Mirontsi beaches. Mwali marks the spot where the turtles lay their eggs; mainly on the beaches of Itsamia, the Nioumachoi islet and to the northwest (Nyambo ya wamaoré and Domoni). The sites' protection by the villager associations and the Ministry of Environment shows a good initiative to raise awareness and to protect this species.

Turtle meat is consumed traditionally. Its uncontrolled exploitation is a clear extinction risk. In 2001, the Mohéli Marine Park was established, and co-management arrangements were established for the sustainable management of the natural resources. The Comoros became an important nesting site for sea turtles in the WIO region. Previously all the beaches of the Comoros were sea turtle nesting sites. But now, the only the area of the Mohéli Marine Park has 45 sea turtles nesting beaches. In 1985, Frazier published "Marine Turtles of the Comoro Archipelago". 25 years later, the data collected are still invaluable to describe marine turtle population dynamics in the Comoros. Since then, Itsamia's village association (ADSEI), the Mohéli Marine Park in partnership with Kelonia (Marine turtle observatory in Reunion Island) and French Research Institute in Reunion Island (IFREMER) developed several research projects.

Most of data collection in Comoros concerns the green turtle (*Chelonia mydas*). Some observations exist on hawksbill turtle (*Eretmochelys imbricata*) and none are available on other species although several personal communications exists on *Dermochelys coriacea* (Frazier, 1985). *Lepidochelys olivacea* and *Caretta caretta* probably do not occur in Comoros. During the 19th and 20th centuries, hawksbill shell trade between Madagascar and Comoros was prevalent. Itsamia and the Ouénéfou Islet were among the most important sites for marine turtle nesting in the region. However, coastlines have in some places been degraded and poaching has decreased populations in Grande Comoro and Anjouan. Mohéli still shelters a large population of nesting and feeding marine turtles. The whole south of this island is a national Marine Protected Area since 2001 with its 45 nesting beaches. The green turtle population is among the most important of the western Indian Ocean. *Eretmochelys imbricata* occur mostly on coral reefs for feeding. Recent studies on Itsamia's nesting beaches (1.7km) recorded more than 5000 nesting females only on one site (Bourjea *et al.*, 2009). They nest all year long with a nesting peak during the dry season from April to August (Figure 14). Each female prepares on average 3 nests per season. In Itsamia, a 25% annual increase in nesting tracks has been observed during the last 7 years of monitoring (2000–2006).



**Figure 14: Estimation of the monthly average number of green turtle nesting tracks from January 1999 to June 2007 at Itsamia's 5 nesting beaches.**

From August 2009, the Moheli Marine Park organised track counting on 34 nesting beaches out of 45 beaches found within the MPA. The MPA has ten localities with 1 or 2 local coastguards who every morning, count nesting tracks or nesting attempts. Technical staff of the MPA record this information in a database. From August 2009 to July 2010, results showed several months with more than 2200 tracks and more than 1500 successful nesting attempts (Figures 15 and 16).

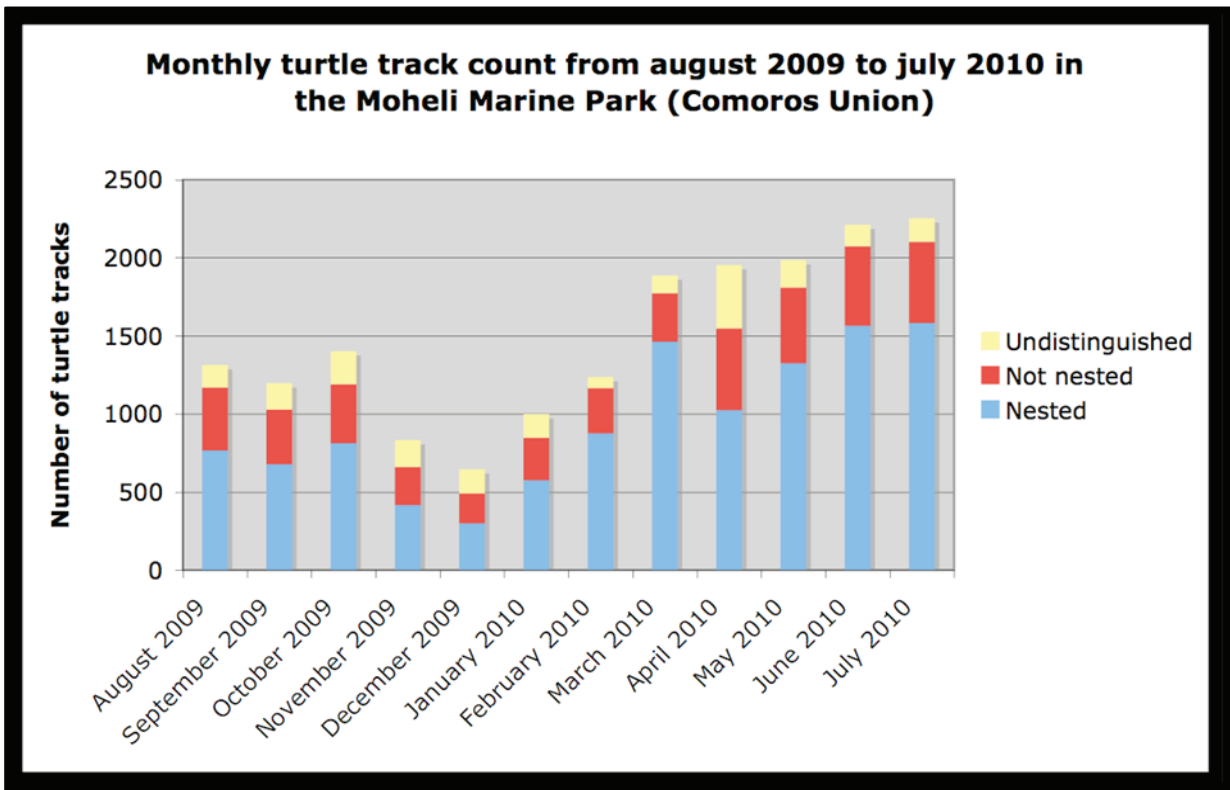


Figure 15: Monthly representation of the daily turtle track count from August 2009 to July 2010 on 34 nesting beaches of the MMP (Mohéli)

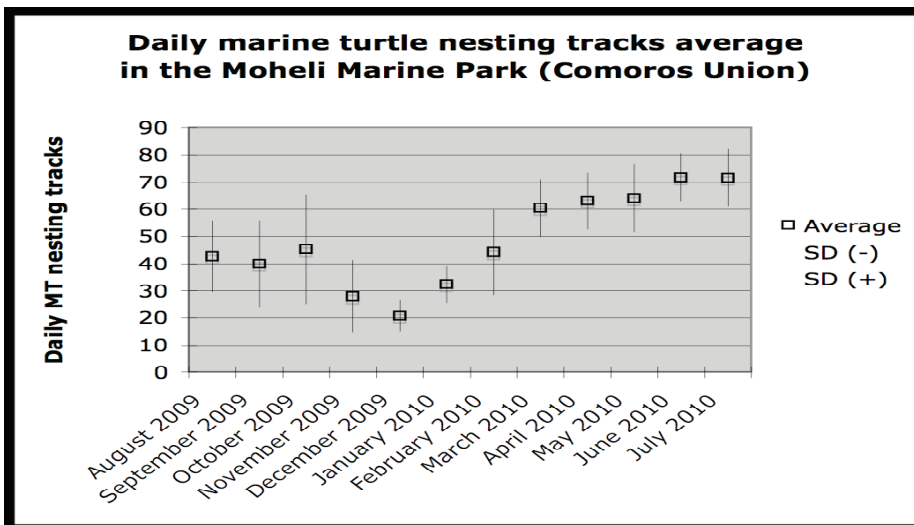
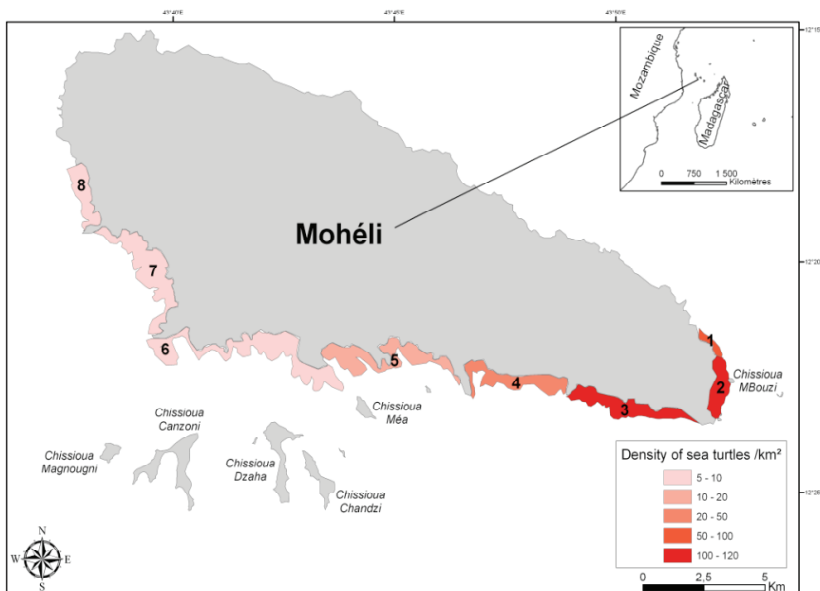


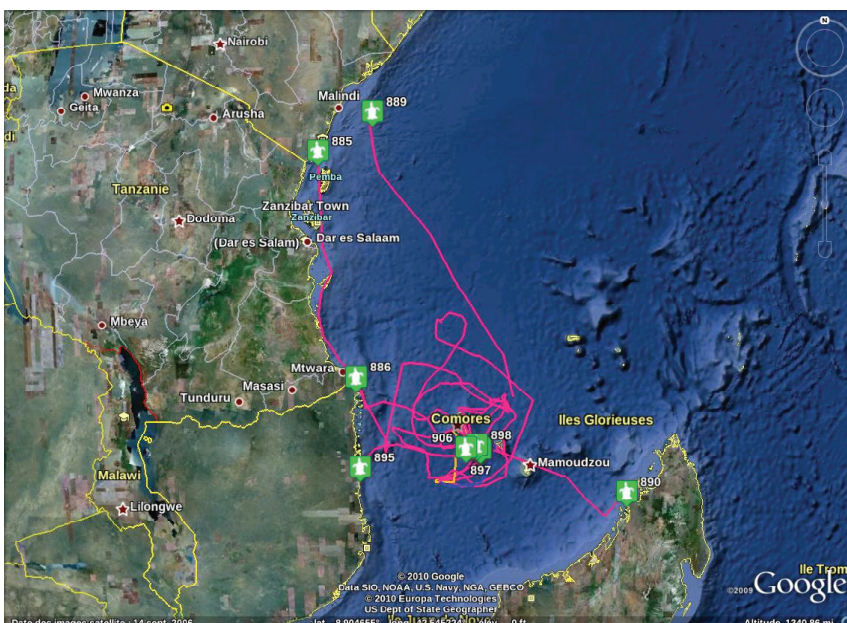
Figure 16: Daily marine turtle nesting tracks on the 34 nesting beaches monitored from August 2009 to July 2010 in the MMP (Mohéli – Union des Comores).

A motorised paragliding survey in 2007 allowed the description of seagrasses that are most frequented by marine turtles. These data, seagrass assessments and dugongs investigations from 2003 give a good overview of the distribution of healthy seagrass beds (Figure 17). Most of the reef flats are preferred by sub-adults of green turtles and the Itsamia region still appears to be one of the most desirable areas for feeding green turtles.



**Figure 17: Map of sea turtle density as observed during the PPG flights over the Mohéli Marine Park in 2007.**

Little information exists on turtle migrations routes and nesting to feeding connectivity. Green turtles tagged in Itsamia have been recaptured (mostly by net fisheries) in Tanzania, Madagascar and also Mauritius. Satellite trackings have been implemented from Itsamia in 2010 (CNRS/Ifremer/Kelonia) and give valuable data on the migration routes from Comoros to the North of Mozambique, Tanzania and Madagascar (Figure 18).



**Figure 18: Turtle migration routes**

### Main threats to turtles and mitigating measures

#### Threats:

In Comoros, fisheries are not well developed and therefore threats to marine turtles are mostly due to coastal human activities. These include habitat destruction due to sand and stone mining on nesting beaches, discharge of groundwater and runoff on marine turtle habitats (coral reefs, seagrasses, beaches), deforestation, and poaching. Despite large public sensitization programs, environmental education in schools and surveillance by coastguards, poaching of green turtle for its meat and eggs is still prevalent in Comoros. A traditional trade for turtle meat is still active in Anjouan and Mohéli. However in some places, such as Itsamia's village, the



population is well educated on the importance of turtle conservation and the whole community is supporting anti-poaching activities.

### **Fisheries interactions:**

Few data are available on fisheries in Comoros and offshore fisheries cannot be actively controlled due to lack of capacity to monitor fishing activities undertaken by EU foreign licensed fishing vessels. Nets are used only on the coastline near the coral reefs, damaging coral reef areas, reducing resources and probably capturing some turtles.

### **Mitigating measures**

Sensitization meetings and education in schools are actually undertaken to minimize poaching. Conservation booklets have been published and distributed during awareness raising programs. Also, an MPA newsletter ("*Mwana wa Nyamba*") were published twice in 2010. To control deforestation, different projects focussed on sustainable techniques for forest restoration and better agricultural practices have been undertaken. However, migration of farmers from 2 other islands is always increasing, necessitating expansion of farming areas. Although there is legislation relevant to turtle conservation, its implementation is weak. It is not rare to capture poachers or people using destructive techniques but judgments are often not strong enough to prevent people from repeating offences. Nightly surveillances are undertaken by coastguards but capacities are limited for arresting organised poachers. The priority is to raise awareness among people from Anjouan and Grande Comore. Moheli has attempted to implement a model demonstration project (supported by the WIO-LaB Project) focussed on ecotourism development based on turtles and other famous sites or species.

### **4.9.5 Birds**

One hundred species of birds have been identified in Comoros. These include 60 breeding species and 39 migratory species. Comoros has the distinction of being located in the path of migratory Palearctic birds. Endemism in birds is estimated at nearly 40% for forest species, with 13 species and 23 subspecies (Louette *et al.*, 1988, 1989). Some species of birds have a very limited range. Among the endangered species whose habitat is Mt Karthala, there are endemic species of birds such as *Otus pauliani*, *Zosterops mouroniensis*, *Humblotia flavirostris*, *Dicrurus fuscipennis*, *D. waldenii* and sub-endemic species such as the Comoros Founingo or pigeon blue (very rare and threatened by hunting) and two endangered species: the black parrot *Vasa coracopsis* (living between 800 m to 900 m) and large dark brown pigeon *Columba pollen* which is found at an elevation of up to 1400 m on Mt. Karthala.

Many species, including some European species, spend winter in the archipelago. Some seabirds, frigate birds and terns stay over in the Comoros without nesting here; these populations may have global significance. The Mchako Rock site is a steep rocky islet without vegetation, protected by its natural inaccessibility. It is a nesting box for sea birds, with an area of 3000m<sup>2</sup> and is one of the Mohéli Marine Park's marine reserves. This rock is located just three kilometres off the extreme eastern coast of Mohéli at the level of Itsamia. Bird colonies nesting here include the Brown Noddy, Sooty Tern, Red-footed Booby and Masked Booby.

### **4.9.6 Exotics and invasive species**

Exotics and invasive species are numerous and scattered throughout the Comoros archipelago. Sometimes they are progressive over the years or longer periods and alter ecosystems and habitats.

The vegetation of the Comoros has been little studied and literature on the vegetation of the archipelago remains poor. The only floristic list for the Comoros has been published to date (Voeltzkow 1917) showing 935 vascular plants, of which 416 are considered native and endemic to the archipelago.

There is no official list of invasive plants in the Comoros, although some of species that have been introduced are known. These include some fruits, spices and some fast growing multipurpose species such as *L. glutinosa*. Other species were introduced as part of reforestation and soil erosion control programmes. These were introduced later in the twentieth century. Approximately 2/3 of these species are trees the remainder being shrubs such as *L. glutinosa*, *L. leucocephala*, *J. curcas*, *G. sepium*, *L. camara*, *C. hirta*, *Senna sp.* It is interesting to note that *Acacia sp.* which were introduced since the 1970s in Comoros to control soil erosion, have become

naturalized and regenerate naturally.

New invasive or potentially invasive species have been reported. *Clidemia hirta* is probably a new invasive in Anjouan and Mayotte, with devastating effects widely visible on Grande Comore and Moheli. An estimated 16 tree species are highly invasive in the Comoros archipelago. These include *Acacia mangium*, *Acacia auriculaeformis*, *Albizia lebbek*, *Cinnamomum verum*, *Clidemia hirta*, *Gliricidia sepium*, *Jatropha curcas*, *Lantana camara*, *Leucaena leucocephala*, *Litsea glutinosa*, *Psidium guajava*, *Psidium cattleianum*, *Senna sp.* *Spathodea campanulata*, *Syzygium aromaticum*, and *Syzygium jambos*. Some herbaceous species are also problem species (e.g. *Hibiscus surratensis*, *Mimosa pudica*) or irritating (*Mucuna pruriens*).

### **2.10 Long term predicted atmospheric changes**

The Comoros islands are vulnerable to the hazards of tropical storms, floods, and rising sea level. Due to the increase in temperature, changes in rainfall and rainfall intensity, there is also the growing number of cyclones and their magnitude which has increased over the recent years. Thus, the Comoros are similarly vulnerable to the constraints that have been identified for Small Island Developing States (SIDS), the Agenda 21 and Programme of Action of Barbados: ecological fragility and economic vulnerability to climate change and natural disasters, low response capacity and management. Comoros does not have a network of monitoring stations for atmospheric changes. Recently, efforts have been made to allow the meteorological service to have reliable data, focusing primarily on data for aeronautics. A tide gauge has been installed at the port of Moroni, with the support of IOC of UNESCO. Comoros has a great need for equipment and capacity building to monitor the emission factors and vulnerability indices tailored to national circumstances, and monitoring of oceanographic parameters (water temperature, salinity, sea level, waves, and ocean currents).



## Human environment

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### Coastal and island populations – current status and trends

The Comorian population is estimated at 705,376 inhabitants (RGPH2003 projection 2011). The population is increasing rapidly with an annual growth rate of about 2.1%. The average density is 269 inhabitants/km<sup>2</sup>. This varies significantly from one island to another and within the islands (Figures 19-21). This density is particularly high in Anjouan where it reaches 316 inhabitants/km<sup>2</sup>, thus creating serious socio-economic problems such as increasing pressures on natural resources, forest degradation, among others. The demographic structure is also marked by the high proportion of young people who represent 53% of the total population below the age of 20. Children under the age of 15 years constitute 42% of the total population. Women of childbearing age represent 23.6%. The total fertility rate of women is estimated at 5.3 children. Life expectancy at birth is 58.3 years for males and 60.3 years for women.

In 2003 the general population and housing census (RGPH) indicated a population of 575,660 inhabitants for the three islands of the Comoros Union and an average yearly growth of 2.1%. Based on a projection, the population was estimated at 670 000 in 2009. If the authorities do not set up a policy to control this demography, the population will exceed one million by 2025. This rapid population growth leads to high pressure on the available land. It corresponds to the return of Comorian migrants from East Africa and Madagascar and is also due to the improvement of sanitary conditions, the generalization of polygamy and the lack of contraception.

The population is unevenly spread over the national territory: Ngazidja (Grande Comore), the most populated island has 296,177 inhabitants, Ndzuwani (Anjouan) 243,732 and Mwali (Moheli) 35,751. The population is mainly concentrated along the coasts and spread over a small insular territory of 1,861km<sup>2</sup> (Ngazidja: 1,147 km<sup>2</sup>; Ndzuwani: 424 km<sup>2</sup>; Mwali: 290 km<sup>2</sup>). National density increased from 240 in 1991 to 309 inhabitants per km<sup>2</sup> in 2003. Ndzuwani Island remains the most densely populated with 575 inhabitants per km<sup>2</sup> and a threshold considered critical in the Nyumakélé region that exceeds 1 000 people per km<sup>2</sup> of arable land, against 258 in Ngazidja and 123 in Mwali.

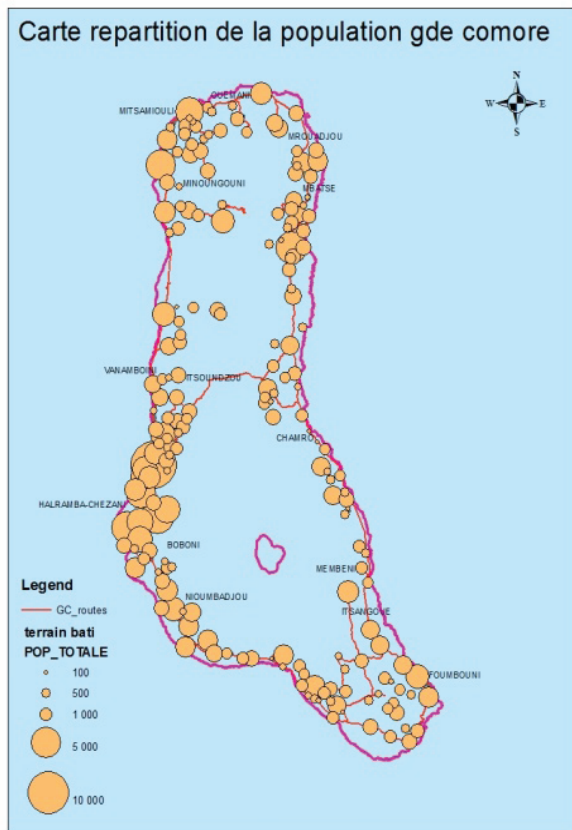


Figure 19 Population distribution in Grande Comore

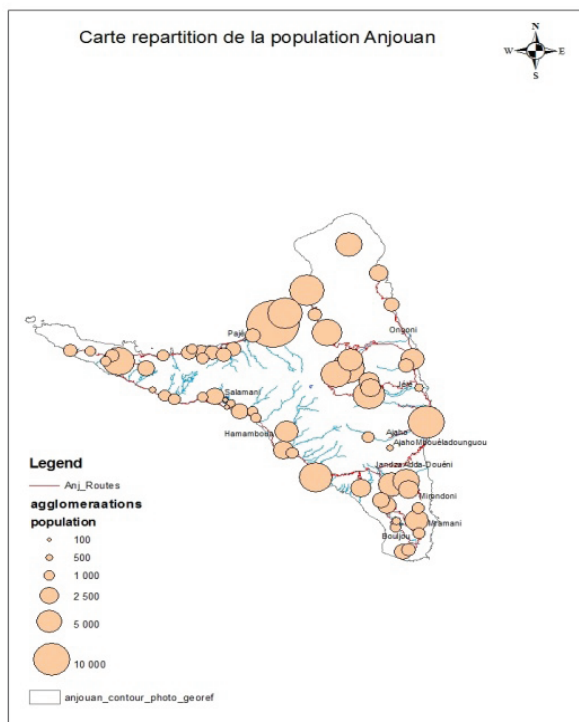
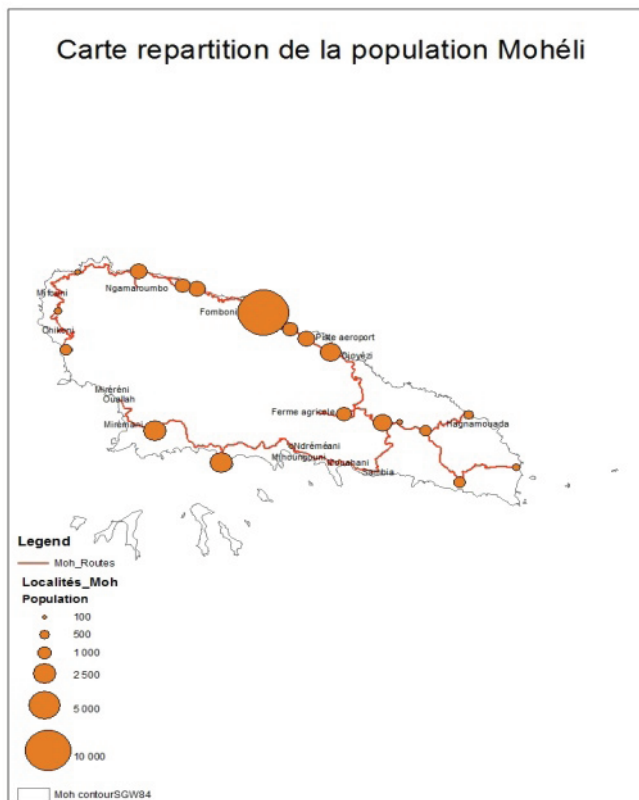


Figure 20 Population distribution in Anjouan



**Figure 21: Population distribution in Mohéli.**

The breakdown per age group shows that young people under 10 years represent 32.2% of the total population. Those aged 10-14 represent 13.8%, adults aged 15-64 account for 49.4% while those aged 65 and over represent a proportion of 4.6%. The size of the female population (289,965 inhabitants) is greater than that of the male population (285,705 inhabitants). 53% of the population is youth under the age of 20 years. The population's average age is 24.1 years. This age structure poses enormous challenges to the country especially in managing education, health, nutrition, vocational training, employment and leisure for the youth. The average household size is 6.3 people. The overall dependency ratio of all children under 15 and elderly over 64 years compared to the population aged 15-64 is 3.4. Meaning that on average an employed person supports 3.4 inactive or unemployed persons. The unemployment rate stands at 14.3%. 18.5% of the female population is affected against only 11.9% of the male population. Nearly two fifths of the population and much more of the rural population are active in the primary sector.

Nationally the gross birth rate is estimated at 35.6 per 1 000. This rate varies according to the islands. 44% of the female population is of reproductive age (15-49). The Comoros, as an Islamic country with pro-birth tendencies, show high fertility rates. The Total Fertility Rate (TFR), despite a downward trend remains very high at 5.3 children per woman in 2003, with disparities between rural and urban areas and between the islands.

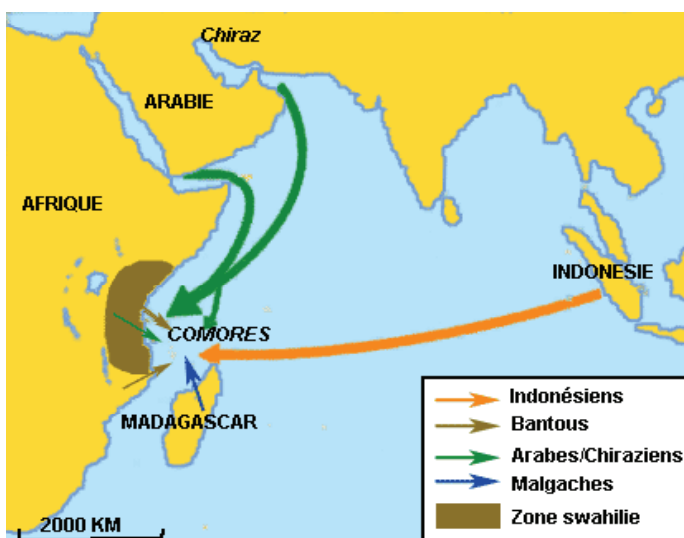
Comoros with a per capita income (GNP) of 680 USD in 2007 is among the least developed countries (LDC). The Human Development Index (HDI) has increased very slightly; it rose from 0.556 in 2004, to 0.576 in 2007, ranking the Comoros 139<sup>th</sup> out of 177 countries. The poverty index (HPI-1) is estimated at 20.4% in 2009. The inflation rate reached 6.5% in 2008 against 4.5% in 2007, directly affecting the already weak purchasing power of the population.

Successive waves of ancient migrants (Figure 22), including Bantu from East Africa, Shirazi from the Persian Gulf, Arabs from the Arabian Peninsula, European and more recently Malagasy and Indian that settled in the Comoros have all, in their own way, helped to mark the Comorian culture. Islam is the religion of almost the entire Comorian population. However, it is mixed with social practices related to local customs and traditions. Religious authorities have considerable influence over the population. At the same time, the religious authority is ultimately only recognized when it is coupled with a traditional authority, notably during the performance of the great wedding (Anda, Chungu). Moreover, in religious beliefs and everyday life, many elements prior to Islam were retained, including the continued existence of pagan and animistic practices like witchcraft, the wearing of talismans, scenes of possession by «djinn», the veneration of spirits, performance of rituals to render them favourable and the belief in the effectiveness of clairvoyance.

The official languages are French that is used in public administrations and as a schooling language and Arab used in Islamic schools and for religious ceremonies. The national language *Shikomori* is derived from Swahili and written using Latin or Arabic script. Justice is composed of a mixed system where the French law, an ancient custom that was established as customary law and Islamic law issued by the Cadi coexist. Polygamy is common.

The National Documentation and Scientific Research Centre (NDSRC) and the National Comorian Crafts Centre (NCCC) represent a wide range of the Comorian culture, a broad product range of their crafts (wood carvings, pottery, basketry, jewellery, embroidery, *shromanis*, *kofias*, *djohos*) and culinary art. The oral tradition is rich in poetry, riddles, legends, tales, proverbs and songs. Cosmetics like perfumes, braids and face masks of sandalwood and coral powder are designed to beautify women. Processions at weddings, election campaigns and the return of pilgrims from Mecca offer a lively atmosphere of celebration and hospitality. Folklore (*Wadaha*, *Deeba* for women; *chigoma*, *gala*, *nkandza*, *sambé*, *dayira* for men) is rich and varied. Traditional medicine relies on healers using known medicinal plants as well as on traditional midwives.

In spite of a law in favour of gender promotion (Constitution, Family Law) Comorian women have a lower status in society than men. Cultural values give much more importance to women as mothers, wives and homemakers. The level of some indicators are too low (enrolment rates for girls 66.4% in 2003; literacy rate: 87 women are literate for 100 men; representation in managerial positions: no woman minister or member of Parliament in the 2011 transition period; a proportion of 30% of the public service in 2005; etc.) or too high (unemployment rate: 18.5% against 11.9% for men; etc.) demonstrates that much remains to be done to meet the MDG deadline of 2015 for the elimination of gender disparities.



**Figure 22: The routes of the migration of the original inhabitants of the Comoros.**

Migration in the Comoros islands is essentially intra- and inter-island. International immigration has declined, while Comorian emigration to the island of Mayotte and to France has increased significantly in recent years (RGPH: 1980, 1991 and 2003). The number of inter-island migrants found in the Comoros is the result of a massive flow of persons leaving Anjouan for the other two islands. Out of a total of 17,149 migrants more than 74% come from Anjouan, the most densely populated island. Grande Comore is the most attractive island of the Comoros. It houses the nation's capital and almost all the socio-economic and administrative activities of the country. In 2003 the number of immigrants was 13 565 or 2.4% of the total resident population. Over time, the Comoros recorded a considerable decrease of immigration. During the 1980 census the proportion was 4.5%, it fell to 3.1% in 1991 and 2.4% in 2003. It should be noted that immigrants are mostly Comorians that were born abroad.

In the past emigration to other countries in East Africa and Madagascar was high, but declined due to the conflicts of 1966 (Zanzibar) and 1977 (Majunga, Madagascar) causing massive repatriations as well as the creation of more restrictive immigration laws in the traditional host countries. Most Comorian migrants choose France as their country of destination. It is estimated that approximately 150,000 to 200,000 Comorians live in France, 50,000 in Reunion and a little more in Madagascar. There are about 300,000 Comorians living outside the three islands of the Comoros. The main reason for migration is to seek employment: 44.1%. Studies and family reasons are placed respectively in second and third position with 26.6% and 17.8%. Health reasons are placed in fourth position with only 7.1% of all emigrants (EDIC Consultants' Reports on «Migration and Poverty»). The Comorian island of Mayotte under French administration hosts a large number of Comorian migrants. However, massive deportations are carried out by the PAF (Border Police) of Mayotte since the introduction in 1994 of the «Balladur visa».

The Comorian population is predominantly rural with 72.1% in rural areas against 27.9% in urban areas. The Comoros are among the world's sparsely urbanized countries. The urban population grew from 128,533 inhabitants in 1991 to 160,862 in 2003, an increase during this period of more than 25.1% or an annual growth rate of 1.9%. One of the characteristics of Comorian urbanization is the particularly strong concentration of the population in three cities: the two insular capitals and the federal capital Moroni. The latter includes 24.8% of the total urban population of the country. Urban growth is partly due to rural exodus, but also because of the admission of villages around the insular capitals as urban centres. It is of concern for several reasons: the unbalanced spatial distribution of the population, irregular occupation and construction, problems of housing, sanitation, urban security, environmental degradation and urban unemployment.

**Table 3: Population distribution per island according to place of residence**

Island	Place of Residence					
	Urban		Rural		Total	
	Number	%	Number	%	Number	%
<b>Mwali</b>	19 581	54,8	16 170	45,2	35 751	100,0
<b>Ndzuwani</b>	69 810	28,6	173 922	71,4	243 732	100,0
<b>Ngazidja</b>	71 471	24,1	224 706	75,9	296 177	100,0
<b>All</b>	160 862	27,9	414 798	72,1	575 660	100,0

### III) GAPS

The demographic data is not up to date, the last census (RGPH) was done in 2003

In the Comoros numerous civil status records are not registered

Dating of the migrations, Mayotte movements considered external

### Sites of historical, religious or cultural significance

The Comorian historical, religious and cultural sites are rich and varied. These reflect the population of the islands by successive waves of immigrants from Africa (Bantu), the Persian Gulf (Arab and Shirazi), Europe and Madagascar. These sites include religious sites, tombs, fortifications and buildings associated with the



sultanates. They deserve to be protected and enhanced in order to enrich the cultural heritage and tourism value of the Comoros. The CNDRS and various NGOs undertake actions to raise awareness about the importance of preserving cultural sites along with the natural environment.

Virtually all of the Comorian population is of Islamic faith (Sunni, Shafi'i etc). Worship takes place in several places, but particularly at the great Friday Mosque where the faithful gather once a week on Fridays and twice a year on the days of the *id* (at the end of Ramadan and on the occasion of a pilgrimage to Mecca) for special prayers. Other places of worship are the *zawiyas* that contain the remains of the heads of Muslim brotherhoods (*chaduli, rifayain*), where religious teachings are dispensed and the initiates gather for *dayiras* to the glory of God.

In the Comoros there is an impressive number of mosques. The Comorians situate Islam's point of penetration to Ngazidja at Ntsaweni where the oldest mosque was built between the IX<sup>th</sup> and X<sup>th</sup> centuries and contains the tomb of Mohamed Ben Assoumani, a marabou propagator of Islam that came from Mecca. At Bangwa-Kuni there is also a very old and ruined mosque; the «Miracle Mosque» built according to local belief without human intervention. Much better preserved is the small *Zawiya* of the *Rifain* brotherhood in Iconi. In Moroni on Badjanani square is the Friday Mosque with its beautiful arches and ornate mihrab dating from 1426AD one of the most beautiful and probably the oldest mosque in the Comoros.

The badly preserved Old Sima mosque marks the Shirazi point of penetration to Ndzuwani. This ancient mosque dating from the fifteenth century was apparently built by a Shirazi named Hassani Ben Issa, founder of the sultanate institution on the island. Domoni (on the East coast) and Chaoueni (in the Nioumakélé peninsula), episodic Shirazi capitals, contain the remains of ancient Shirazi mosques. At Mutsamudu the great Friday Mosque has conserved its top minaret despite reconstructions done to the rest of the building. Not far away stands the Mohamed Said mausoleum, last sultan of Ndzuwani (whose sovereignty was finally abolished by the French colonial authorities in 1909) who died in 1932.

In nature, especially in the Anjouan bush, sacred places or *ziaras* exist, marked by rocks, trees or water sources. They testify to the continued existence of pre-Islamic beliefs, although declining. In these places reputedly inhabited by «genii» (djinnns) offerings are made and rituals are performed to render the *djinnns* favourable when having to deal with risky business, to get rain after a long drought, protection, etc. Some items can also be sacred and inhabited by spirits, such as the Sacred Pool in Old Sima on Ndzuwani, subject of a cult described by J. Hebert C. (1960). This pool, which would have been used to bathe the devil's sons (the sick) is inhabited by a «genii», «a spirit endowed with supernatural power» and is the subject of worship, protector rites at a child's birth to protect it from disease, collective propitiatory rites at the beginning of the agricultural year in order to obtain good crops. Spirits also inhabit certain zoological species such as eels; a few miles from Domoni a pool containing sacred eels is the subject of worship. In an article of the 'Africanists Society' (1960), Herbert J. C. describes Anjouan agricultural rites: the *koma* game at Wani, *Trimba* ceremony at Nioumakélé, *mudanda* game at Ouzina. These collective rites take place at the beginning of the agricultural year before the rainy season. (Robineau 1967)

In the Comoros, being a Muslim country, the dead are buried in a pit directly in the ground. The royal tombs or those of religious leaders, imams, or brotherhood leaders are masonry structures. The tombs of the brotherhood leaders are located in the *zawiyas* where they execute *dayiras*. Some ancient tombs on the east coast of Ngazidja (at Bandamadji and Iwani) have a Latin cross etched into the lime mortar. According to local tradition they attest of the presence of the first Europeans (Portuguese) to have visited the island. A curious fact is the discovery at Iwani in a tomb with a Latin cross of some pottery shards together with a sheep's (or goat or kid) shoulder blade and femur head which could be offering remains (Viillard 1971). The most famous ancient tombs on Ngazidja are those of the sultans Ntiba Kandzu (XIV<sup>th</sup>) in Ntsudjini, Ntiba Mlanao (XVII<sup>th</sup>) in Iconi and that of the marabou Mohamed Ben Assoumani (X<sup>th</sup>), the propagator of Islam on the island in Ntsaweni.

Fortifications are preserved in many sites on the islands. These defences reached a large size and were quite extensive during the Malagasy invasions of the late eighteenth and early nineteenth centuries. On Ngazidja towns like Fumbuni, Icon, Moroni, Itsandra, Ntsudjini and Ntsaweni had fortifications. The remains are preserved in many places and bear witness to the construction effort of Comorians and their extraordinary determination to defend themselves. Fumbuni was the first victim on Ngazidja of the Malagasy invasions and was therefore the first to build ramparts. Iconi also has a fortified site, curiously, not around the city. The defence was built around the cliff edge of a nearby crater to the north of the city. The site was the subject of protective works after the first Malagasy invasion in 1798. The expansion of the Moroni Medina wiped out most of the old enclosure of which there are nevertheless still some pieces of wall visible. The walled city of Itsandra is dominated by a strange trapezoid-like fortress connected to the city by a path lined on both sides by a wall pierced here and there by the modern coastal road. Ntsudjini located on a slope 500m from the sea has been spared from human destruction. The new asphalt road that goes up to Bahani however, opened a breach in the wall. (Verin and Wright 1980)

### III) GAPS

Many sites are still unknown due to inadequate research or because they have been subjected to degradation following population and economic pressure

No directory of the sites of religious and cultural interest (location, size, condition)

Approximate dating of the events

Data on non-Islamic religious sites is outdated

Human health and education

The National Health Development Plan (NHDP) - Outlook 2015 is the country's health development reference. The plan's strategic axes are aimed at slowing population growth, reducing maternal and infant mortality and morbidity, ensuring a more balanced nutrition to the population and improving access to essential medicines.

The reform of the health system introduced a structure composed at the central level of the National El Maarouf Hospital, the National Autonomous Pharmacy of Comoros (PNAC) and the National School of Medicine and Public Health (ENMSP). At the island level there are Regional Hospital Centres (CHR). The peripheral level (the basis) consists of Health Districts (17 SD) covered by two Surgical Medical Centres (CMC), three Urban Medical Centres (CMU) and health posts (49). These three levels are complemented by a network of Army health clinics, the CARITAS Catholic Mission clinic, a private sector in full expansion and various community health facilities.

Thanks to the existence of these structures, geographical access to a health centre within a radius of 5 km is estimated to average 63%. The attendance rate of health facilities is 10.25%. The average bed occupancy is between 20% and 60% with variations depending on the season and the health centre. The population / health personnel ratio is two doctors, three state nurses and two state midwives per 10 000 inhabitants. Life expectancy at birth increased to 65.5 years in 2003 (64.3 years for males and 66.9 years for women). (Health Personnel Census Report, Vice-Presidency of the Ministry of Health, 2007)

Despite the efforts made, including training and equipment, health services deteriorated. The state budget percentage devoted to health services suffered a steady decline; it fell from 594 million Comorian francs in 2000 to 408 million in 2003 (or from 5% to 3%). Frequent stock shortages of reactants in the laboratories or of essential drugs and the inadequate numbers or even the absence of doctors lead people to travel abroad for care. The high costs of health services and the deterioration of their purchasing power force people with low income to resort to traditional methods (plants, witchcraft, traditional midwives etc.) harmful to their health.

These shortcomings, combined with the deteriorating hygiene and sanitation conditions, largely explain the persistence of certain diseases such as malaria, intestinal parasites, lymphatic filariasis, acute respiratory infections and diarrheal diseases. They are also behind the outbreak of some potentially epidemic diseases such as cholera (1975, 1998, 2001), dengue fever (1992) and *Chikungunya* (2005).

The morbidity and mortality associated with certain non-contagious diseases including mental illness, blindness, cancer, diabetes, cardiovascular disease and hypertension are still worrying. Data on these diseases is almost

non-existent.

The immunization coverage of the six diseases targeted by the Expanded Immunization Programme (EIP) fell below 70% in 2004. The maternal mortality rate remains high at 381 per 100 000 live births in 2003. Many women die following a pregnancy or childbirth because of the high fertility rate and huge number of homebirths (57% according to EDS 1996), often without the aid of qualified personnel (38% according to MICS 2000). Comorian children are still subject to high mortality risks even though the infant mortality rate has substantially improved to 49 per 1 000 in 2007. The rate of child mortality also significantly improved to 66 per 1 000 live births in 2007 (UNICEF 2009).

Malaria remains one of the country's most important public health problems. The Strategic Plan against malaria introduced nets on a large scale: 72% of households have nets, but the use of treated nets (much more effective prevention) is much less common. Available data indicate that in 2006, malaria was the country's leading cause of overall morbidity (42%), was the main reason for outpatient visits (38%) and hospitalizations (60%) and contributes to maintain high absenteeism rates in schools and workplaces.

Tuberculosis, supposedly defeated, appeared again with drug-resistant bacilli strains. In the Comoros it remains a shameful disease thus leading to a low detection rate (32.3% in 2004) despite good and free care.

AIDS has become a serious problem. The HIV infection rate (0.025 in 2003) is still low. However, an explosion is possible because of low condom use, the increase of illegal prostitution, increased trade with countries heavily affected by the pandemic and with high prevalence of STIs (4, 6% in 2006). In December 2007, an estimated 97 persons were infected with HIV, of which 34 died. Of the 63 PLHIV, 29 are being cared for in Reunion and 14 active residents are on ARV.

Illiteracy is a major obstacle to social and economic development. The MEN 2007/2008 Dashboards show that 23.9% of school-age children do not attend school and those who are at school are leaving the education system too early. The net school enrolment rate was 76.1% and the rate of primary school completion is 57%. The general literacy rate's evolution is downward, from 71.8% in 2003 to 61.9% in 2007. Women are most affected by illiteracy. According to MICS 2000 the cumulative illiteracy rate is 40.9% and particularly concerns the productive population.

Some forms of child malnutrition are still quite high. In 2008 13.8% were underweight and 6.4% emaciated. The proportion of children lagging in growth declined significantly from 42.3% in 2000 to 27.8% in 2008 (UNICEF 2008).

According to the final 2009 PRGSP, 15% of the Comorian population have access to drinking water. Only a limited number of people in major cities and nearby towns are connected to the city networks. The entire rural population, more than two thirds of the population, is thus subjected to the uncertainties of rain and surface water of insufficient quality. The current water supply networks are outdated, inadequate and in poor condition. It repeatedly deprives the population in the capital and surrounding villages of drinking water for several days. The islands of Ndzuwani and Mwali depend on surface water from springs or rivers, while the population of Ngazidja get their water primarily from rainwater collection and groundwater. More than half of the Ngazidja households use rainwater collected in tanks.

The risks of waterborne diseases and pollution are very high because of the lack of well and pumping station protection and the fact that no water quality monitoring and control mechanisms exist. Only a few salinity tests are occasionally and partially carried out on Ngazidja.



**Figure 23: Dumping of garbage directly on the seashore in Comoros.**

With rapid population growth and uncontrolled urbanization, household waste production (estimated average of about  $1\text{m}^3/\text{person}$ ), untreated hospital waste and emissions associated with transport activity, increased significantly. Waste production is not managed by any suitable collection and processing structure. The population disposes of their garbage along the road, in the sea along the coast, in a river or near their homes (see Figure 23). The marine flora and fauna are particularly affected by the garbage and oil spill (tankers passing through the Comorian waters) pollution. Uncontrolled/illegal mechanic workshops increase noise pollution. Open air waste incineration causes toxic fumes and foul odours that in turn cause allergies and lung diseases. These unhealthy conditions promote the spread of disease vectors. Among others, this situation has a negative effect on the tourism potential. In the Comoros, sewerage, drainage and evacuation or wastewater treatment networks do not exist. On Ngazidja, there is a risk of groundwater pollution by septic tanks and their seepage.

### **III) GAPS**

No harmonized health information system which is the cause of some data inconsistencies  
Health data are outdated

## **3.4. Infrastructure**

### **Roads**

The Comorian national and regional road network totals 849 km with 665 km of tarred roads and 184 km of dirt roads and tracks. It is spread over the islands as follows: 495 km on Grande Comoro (58.3%), 256 km on Anjouan (33.2%) and 98 km on Mohéli (11.5%). The Wallah II-Miringoni section of about 9 km should allow circling Mwali and the 7 km Hajoho - Jimlimé axis on Ndzuwani is in the process of being opened up. The length of urban road networks amounts to 56.615 km; 30 km for Grande Comoro (53%), 18 km for Anjouan (32%) and 8.5 km for Mohéli (15%). In 2009 thanks to the Libyan donation of 3,860 tonnes of pure bitumen for the islands' road rehabilitation and reinforcement, roads in Moroni were constructed and rehabilitated (14 km coated and 16 km with single and double layered surfaces). The dilapidated state of the road network is a handicap for the economy. This is valid for both goods transportation and in terms of tourism activity. Road safety is a significant concern given the poor and narrow roads as well as lack of road signage (signs, markings, priority indications). Traffic in urban areas is becoming more congested and makes the socio-economic infrastructures such as hospitals, ports, airports, markets, etc. difficult to reach. Coastal erosion has a serious impact on the road infrastructure. The road network is degraded. The 2007 Finance Law created a special Public Treasury account just for road maintenance called the Road Maintenance Fund (RMF). This account is funded by 15% of the single tax on petroleum products (TUPP). This mechanism is struggling to function properly. The government's challenge is to ensure the effective transfer of the RMF funds and to use them only for road maintenance and repairs.



## Ports and Harbours

The Comorian harbours play a vital role in the country's insular economy where the consumption of manufactured goods, food and energy products such as hydrocarbons come almost entirely from imports. The ports also provide transportation of goods and passengers between the islands. Built in 1982 with ADB funding the Mutsamudu harbour on Anjouan is the Union of Comoros' only deep water port that welcomes large vessels. It has a 173m pier with a 9m draught and two 80m docks with 3.80m draughts as well as a 5 000m<sup>2</sup> covered store. Traffic grew rapidly after 2005 when *Spanfreight*, a Kenyan subsidiary of *Maersk Sealand* was awarded the port's stevedoring contract. Since then the Mutsamudu port acts as a hub/ redistribution centre (cargo consolidation/deconsolidation, container storage and their transhipment by boat/barge to other regional ports). The terminal receives more than 30 000 containers each year. Just over 10% of this traffic is redirected to Ngazidja, the main island, which do not have a deep water port. The handling is done by the *Anjouan Stevedoring Company (ASC)*.



**Figure 25: Port of Mutsamudu, Comoros.**

This harbour has two docks of which the main dock is 100m. There is also a beaching ramp, a specialized container terminal (with a maximum capacity of 800 20' containers) and three covered stores (2,500m<sup>2</sup>). More than two-thirds of the country's business is focused on Grande Comore, that does not have a deep water port. Given the shallow draught of the harbour (4.5 m), large vessels, let alone tankers, cannot access the Moroni harbour. This draught requires mooring and transhipment at sea. With the arrival in 2007 of the new company, *Gulf Com*, that has a steel barge equipped with a crane and a mobile crane in the port, the situation has improved. Goods landed in Mutsamudu (the country's large vessel port) are forwarded to Moroni by a barge with a 70 container capacity chartered by *Spanfreight*. This barge performs shuttles between the two islands. In order to decongest the port, the CPA undertook to separate international traffic from inter-island traffic. For this purpose fences and walls were erected. Many drawbacks limit the Moroni harbour's operation: the narrowness of the docks, immobilized ships or inter-island coastal vessels crowding the piers, heavy swell at certain times of the year, difficult road access as it is often jammed by city traffic, no fire fighting equipment on site. Despite these drawbacks this port has an oil terminal (with *sea line*). The construction of a deepwater port at Grande Comore is planned. In 2001 EDF funding was used to create marine access to Boingoma on Moheli. It is unprotected from the sea and docking is very difficult. It can only be used 50 to 70% of the year meaning that the coastal beaches of Fomboni, Hoani and Nioumachwa constitute the island's main landing sites. There is no storage and handling equipment on the docks. In the absence of adequate equipment, goods are first unloaded on Grande Comore or Anjouan before being taken to Moheli. This results in successive transhipments with all the consequences that it entails.

Transportation between the islands is carried out by a fleet of twenty motorized low tonnage (15 100 tons) wooden or metal ships. The *Kwassa Kwassa* fibreglass boats, although prohibited to transport passengers, organize frequent shuttles between the islands which result in tragic accidents, particularly on the stretch of sea between Anjouan and Mayotte. Connections between the islands are regular during the high season

(June to October), but suffer from irregularities from November to May (rainy season). Security conditions are poor for both passenger and vessel as well as for the cargo.

### **Airports**

The Comoros has an international airport (AIMPSI) located at Hahaya, Grande Comore and two secondary airports, one in Wani (Anjouan) and one in Bandar es Salaam (Moheli). Air cargo remains modest. The company COM'AIR Assistance (established 1998) manages the handling and provides passenger ground assistance. They have specialized equipment and an air cargo hangar. The number of passengers boarding and disembarking at AIMPSI is limited: an estimated 150,000 passengers in 2008 of which 90,000 were on international flights and about 60,000 on domestic flights. Tourist numbers declined sharply after the Galawa Beach Hotel closed in 1999 and some flights, particularly Emirates, were stopped. Five international airlines fly to AIMPSI: Yemenia, Air Austral, Kenya Airways, Air Madagascar and African Express. Air traffic growth prospects are good, given DGACM's «Open Skies» policy and the authorities' concern to position AIMPSI at ICAO standards. To this end, significant work has been done: 1. with funding from the People's Republic of China: a new terminal was built, parking established, the runway impact zones were strengthened and closure made possible (structure inaugurated in May 2008) and 2. AFD financing: rehabilitation of the lighting, improved air navigation security system and rehabilitation of the control tower. Becoming a member of ASECNA (January 2004) improved safety and air navigation. For passenger comfort a duty-free shop and a VIP lounge are now available in the international zone.

Anjouan (in Wani) and Moheli (in Bandar es Salaam) each have a secondary airport with similar sized runways; 1 350m long and 30m wide. The Moroni-Iconi (Grande Comore) airport is no longer operational. Both airports lack working night lighting and sea rescue, fire safety and closure equipment. Two companies with reduced capacity (17 seats) propeller aircraft (LAT) offer regular inter-island flights. They are Comoros Aviation and Air Services Comoros. Comoros Aviation also conducts regular flights to Mayotte and other regional countries.

### **Telecommunications**

Telecommunications is under the monopoly of the state company «Comores Télécom» created in 2004 to take over after the split up of the National Post and Telecommunications Company (SNPT). Comorian telecommunications started diversifying from 2004. Consequently the country entered the era of mobile telephony. Other services (networks) were created, including CDMA (2006), ADSL. These days there is at least one phone booth in each village. Landline coverage is 2.9% and that of the mobile network is 22.8%. Internet coverage is more recent. The growing number of private internet cafes got their share of the market. 'Comores Telecom' prices remain high when compared to the tariffs in the other regional countries. Becoming a member of the EASY project enabled the country's connection to the high speed and broadband submarine optical fibre cable that runs along the East African coast. The cost was covered by 24 billion Comorian francs out of own funding (25 million Euro) and a loan from the Chinese cooperation (32 million USD). Such a connection will, as soon as it is launched in June 2011, spread broadband technology in the archipelago. The government decided to liberalize the sector by granting a license (mobile) to a private Kuwaiti interest, thus ending the monopoly of 'Comores Telecom'.

### **III) GAPS**

Lack of statistical data on the performance of road transport  
The information in the air and sea transport manifests is not used  
No data on passenger and freight traffic  
Data on certain types of telecommunications networks

### **3.5 Economy**

The Comoros have an annual total economic value of ecosystem goods and services amounting to 122 million USD. The direct use value is equivalent to 55.4% of total value while the indirect use value is equivalent to 44.6% of the total value. The main direct use benefit comes from extractive use of natural resources (fisheries, raw material and ornamental resources harvesting), which is up to 37.1% of total economic value. The contribution of non-extractive uses (e.g tourism and recreation) is at 18.3%. On the other hand, indirect use benefits are mainly provided by coral reef ecosystems: 13.3% for coastline protection, 9.7% for climate regulation and 4.7%

for the maintenance of genetic diversity. Given the restricted extent of mangroves for Comoros, mangroves services have little economic

For Comoros, regulating services are more significant than the provisioning and cultural services. However, fisheries are important for Comoros as it represents 37% of the total economic value of ecosystem services. In addition, it provides a direct food supply to the local population: the yearly fish consumption per capita is 20 kg (WRI, 2008). Given the amount of Comoros GDP which is about 557 million USD (CIA, 2009), the total economic value of goods and services produced by marine and coastal ecosystems represents 21.9% of the GDP. The total economic value for goods and services produced by marine and coastal ecosystems is about 14,956 Million USD (Table 4).value.

**Table 4. The total economic value for goods and services produced by marine and coastal ecosystems in Comoros**

	Direct use value (Mus\$)	Indirect use value (Mus\$)	Total (Msu\$)
<b>Provisioning Services</b>	Food production : 44 Raw material extraction : 1 Ornamental resources : 17		62
<b>Regulating Services</b>		Climate regulation : 546 Disturbance regulation : 7 Shoreline protection: 1	554
<b>Cultural Services</b>	Tourism & recreation : 235		235
<b>Supporting Services</b>		Nutrient cycling : 2,934 Maintenance of genetic diversity: 11,173	14,106
<b>Total</b>	295.8	14,660	14,956

## 4. Coastal Livelihoods Assessment

A comprehensive coastal livelihoods assessment has been carried out. Chapter summaries are presented below, and the full Coastal Livelihoods Assessment may be found in Annex IX for further information.

### I. Small-Scale Fisheries

The Small-scale fisheries in Comoros employ 6% of the country's population, with women mainly being employed in post-catch operations, while 30% of the population is dependent on the fishery. The sector contributes 8% to GDP, 24% to agriculture GDP and also makes up 5% of total foreign exchange annually, making fishing not only a net supplier of foreign exchange, but also a key component of the country's balance of payments. The small-scale fishery is, in this respect, a vital link to the global economy for the Comoros.

With the government's goal of replacing frozen fish imports in the 1980's through targeted investment and development, production output tripled from 1986 through 2004. This has been followed with further government commitment with the 'Comorian Fisheries Development Strategy' in 2007, which emphasized the responsible and inclusive development of the small-scale fishery. The government has also fostered development in the small-scale fisheries through revenue accrued from the larger industrial fishing industry, with upwards of 60% of revenue from fishing agreements being made available for the development of a cold chain and fishermen training programs. This has allowed the small-scale fishery to indirectly grow and benefit from the industrial fishery. Small-scale fishermen are also permitted to fish without licenses, as well as fish in protected areas, both of which are privileges that have not been granted to the industrial fishery. Both the industrial and small-scale fisheries, however, continue to target the same resource (tuna), making for potential conflicts of interest in the future. Many of the government's programs have also not been operational due to the lack of available capital and capacity, which has hindered further development in the small-scale fishery. Likewise, heavy exploitation of the coastal zone may also become problematic if monitoring and regulatory techniques are not improved.

State capacity and infrastructure remain constraints on the sector, however, government commitment, along with an improving investment climate and potential for further increases in production, makes the small-scale fishery a prospect for strong and sustainable development in the future. While the coast is becoming over-exploited and access to credit remains weak in the sector, the international demand for fishery products, as well as the existence of untapped niche markets, highlights the many opportunities that the small-scale fishery could capitalize on. With greater attention devoted to sustainable production, sanitary processing and better marketing, the small-scale fishery has much potential for future development.

### II. Tourism

Tourism contributed between 2% and 4.1% of total GDP in 2005, generating 500 direct jobs, 80% of which were in the hotel sector. Tourism also generated 500 indirect jobs in 2005, largely around the food-supply and handicrafts sectors. 90% of total bed capacity in the sector is located on the island of Grand Comore, which contains the country's only international airport and business hotel. International arrivals have been increasing in recent years, however, both total arrivals and leisure-based travel has been declining, with leisure based travel decreasing from 27,000 in 1994 to just 3,000 in 2007.

The greatest constraints in the sector are clearly in capacity. Limited accommodation capacity, banking facilities and transport have all been highlighted as weaknesses in the sector, while political instability and a lack of disposable capital at the community level continue to constrict growth. Issues of sustainability have also been raised, not only in regards to natural resources, such as water, but also in relevance to donor support. Illegalities in investor-government relations, as well as unrest in rural areas, have also been highlighted as challenges in the sector.

There are, however, numerous opportunities that can be capitalized on to mitigate some of the aforementioned constraints. For example, the potential for new international airline connections could lower travel costs, while opportunities for eco-friendly hotels and construction materials could help in the development of eco-tourism in the country. The country's ideal climate, natural environment, and rare marine resources also give the sector



a comparative advantage over other tourist destinations, while its unique cultural heritage and active volcanoes could also help in marketing the sector abroad. Nevertheless, before these strengths can be sufficiently utilized to the benefit of the sector, political instability needs to be improved, particularly as a means to establish certainty and confidence in the country's business environment and overall economy.

### III. Mariculture

With no designated mariculture zones, limited fresh or brackish water resources, and limited areas suitable for culture, there are currently no operating mariculture activities in the country. There are, however, some opportunities for growth in the sector.

In Grande Comoros, northern areas such as Mitsamiouli and Bouni, as well southern areas, including Sima Amboini and Foumboni, have been recognized as having potential for mariculture development. Likewise, the south west coastline of Moheli, in particular in the vicinity of the Parc Marin de Moheli, provides an ideal environment for cage cultures to be developed. These opportunities are also indirectly supported with the reduction in lagoon fisheries, which could potentially create greater incentives to develop mariculture activities. However, with limited mangrove areas and accompanying salt flats that could be used for pond culture, any potential mariculture development is somewhat constrained.

While capacity, infrastructure and the lack of available data continue to constrain the development of the sector, the central and local government has shown a willingness to support its development. Similarly, with abundant opportunities for business development and job creation in the sector, mariculture has the potential to create an alternative stream of income in the country. Mariculture activities could also be utilized as an alternative method of coastal zone management, which could potentially create incentives to reduce environmental degradation on the coast. Overall, with the proper bio-technical and financial assistance, mariculture has the potential to become a new industrial sector in the Comorian economy.

### IV. Agriculture and Forestry

Agriculture and forestry currently employs between 70% and 80% of the total Comoros population, accounting for nearly 45% of GNP and totaling 98% of all exports. It continues to grow at an annual rate of 2%. Vanilla is the most dominant commodity in the sector, making up 60% of all exports, making it the principal source of foreign exchange in the country. National agricultural production, however, accounts for only 40 per cent of the country's food needs, wherein, production for domestic consumption contributes some 47 per cent of the sector's added value. Food imports, particularly rice, thus consume much of the country's foreign exchange.

With much biodiversity and diverse landscapes, Comoros receives a considerable amount of international support that focuses on natural resource conservation. Forest destruction, due to rapid agricultural expansion, has however led to upwards of 57% of total forest area being degraded. With the total population in the coastal areas expected to increase to 65% of the total country population by 2050, degradation of the forests, which have been valued at \$698 Million USD, could be fatal for connected coastal ecosystems.

The government and the international community has, however, shown a strong commitment to promoting the sustainable use of the country's forestry and agriculture. With the adoption of the National Environmental Policy in 1993, the Comoros government began promoting the protection of biodiversity and environmentally viable agricultural production. The country has also received backing from IFAD and the UNDP to promote training in sustainable agriculture and climate-change management respectively, both of which emphasized the empowerment of local communities in managing their resources. Existing policies in the sector have also been studied and implemented using empirical evidence, which instills greater confidence from both donors and investors. While an over-reliance on commodity exports continues to attach the economy to volatile commodity prices, the country's beautiful landscape, as well as the great potential for sustainable eco-tourism, highlights the many opportunities within the sector for development. With increased capacity at the local level, along with diversification into food-based agriculture for domestic consumption, the agriculture and forestry sector has the potential to revitalize both the Comorian economy and environment.

### V. Energy

There is very little activity in oil, gas and biofuels in Comoros. The country has no proven oil and gas reserves, forcing it to import the majority of its petroleum from Tanzania and other mainland African states. The country consumes an estimated 1,000 barrels of oil per day, with imports accounting for 750 barrels per day, often

resulting in supply deficits. In the downstream sector, the state-owned Société Comorienne des Hydrocarbures (SCH) is responsible for the importation, storage and distribution of oil and LPG. In the past, the SCH has poorly managed fuel and LPG needs and stocks, creating recurrent disruptions. The state-owned entity is, however, currently being privatized, while there are also reports that maritime fuel distribution between Anjouan and Moheli is also being privatized. Due to limited available land, there are currently no biofuels projects in the country.

Numerous constraints have been identified in the sector. For example, data on the sector is not easily available, there is no record of oil and gas policies and there is no record of reports or projects, all of which severely constrains analysis and planning in the sector. Comoros also has a relatively weak central government system which, in conjunction with political instability, makes policy implementation extremely difficult. Under these conditions it has been suggested that any discovery of oil could not only lead to more political turmoil, but would increase the risk of spills and accidents. The country's small, but fast growing, population, along with its vulnerability to climate change and rising sea levels, were also highlighted as weaknesses in the sector.

There are, however, strengths and opportunities highlighted in the sector report. For example, the privatization of the SCH has the potential to increase efficiency in the downstream sector, while local and international NGO's could potentially serve as industry watchdogs, which is particularly important considering the inefficiencies present in the central government. The decentralization of resource management could also be very positive, particularly as a means to empower communities to be responsible for their own resources. The potential for eco-tourism is also promising, not only as a means to generate employment, but also as a means to shift labor away from the more resource-intensive sectors. Nevertheless, the country does remain extremely dependent on an assortment of imports, and given that all of its petroleum is imported from neighboring states, it is likely that strategies to mitigate the over-dependence on non-domestic resources will be required before any substantial progress can be made.

## **VI. Ports and Coastal Transport**

There are four major ports in Comoros, located in Moroni, Fomboni, Mutsamudu and Mayotte. The main port in Moroni is accessible by road, however, dangerous currents and water depth force ships to dock away from the port, leaving ship cargo to be transferred to the port through smaller vessels. The port in Mutsamudu has access to important fish-processing storage facilities, while the Fomboni and Mayotte ports also both have links to the fishing industry.

While the government continues to operate the port in Mayotte with French assistance, the operation of the other ports has been contracted out to Gulf-state companies, most recently with the UAE based container port management company GulfTainer at Moroni and Mutsamudu. This business with Gulf-state partners has also created opportunities for tourism from other countries in the Middle East, as well as made possible the potential upgrades in port operations and technology.

Competition in fishing and tourism from Madagascar and other island states, along with the threat of piracy due to the country's proximity to Somalia, continues to constrain ports and shipping in Comoros. However, investment in ports from the Middle East, along with the potential for an offshore financial center, does highlight the potential for growth and development in the ports and shipping sector. If political stability can be advanced, the sector will benefit greatly.

## **VII. Coastal Mining**

There are no commercially exploitable mineral resources in the country, thus, energy, cement, steel and other materials are imported. New construction techniques using volcanic ash are, however, expected to decrease the country's dependence on foreign cement and sand imports. The mineral industry in the Comoros is still nevertheless limited to the production of local building materials.

The use of beach sand for construction materials has inevitably led to the erosion and degradation of the country's beaches. While the country does have environmental regulations, no management plan on sand mining has been implemented to date. The United Nations - Division for Ocean Affairs and the Law of the Sea - has, however, conducted two studies with recommendations for management of the Comoros coastal zone.

While coastal mining does not present any immediate commercial opportunities and the affects of sand mining remain problematic, numerous local NGO's, such as **The Association for Intervention for Development and the Environment (AIDE), Action Comoros and the Management Committee of the Marine Park of Moheli, continue to monitor the socio-economic and ecological status of the country's coastal zone. Thus, while the central government lacks the capacity to monitor the impact of economic activity in the coastal zone, there are agencies on the ground that continue to do so.**

### Conclusions

Each sector has had, and will continue to have, a distinct impact on the socioeconomic and environmental status of the coastal communities concerned. There are many constraints that remain constant across sectors, such as political stability, the over-exploitation of natural resources and infrastructure, all of which have had a widespread impact on all of the sector's considered in the coastal livelihoods study. There are also numerous strengths and opportunities apparent, including the commitment to sustainable development, support from government and international agencies, as well as the empowerment of local communities. In this respect, while each of the seven sectors have their own distinct institutions and processes that are unique to the sector in question, they are nevertheless extensively linked economically, socially and environmentally.

One clear link between many of the sectors is the constraint posed by poor infrastructure and weak capacity. In the small-scale fisheries, a lack of electricity and water at fishing sites has constrained storage and cooling capacity, which subsequently affects the marketability of the product. In the mariculture sector, a lack of relevant policy, institutional capacity for effective coastal monitoring and data management, continues to constrict the regulation of coastal zone degradation and the general development of mariculture activities. In the agriculture and forestry sector, resources to implement policies for improved coastal zone management and development are lacking. The same can be seen with the management of sand mining. However, despite these constraints, many projects and sectors have been able to develop with domestic and international support. For example, investment in infrastructure and training in the small-scale fisheries has allowed the sector develop side-by-side with the larger industrial fleets. Likewise, good water quality and governmental support could be very helpful for the potential development of mariculture activity, while international support to assist in improved coastal environmental management, as well as more empirically-backed data and policies, have been beneficial in the agriculture and forestry sector. Similarly, the ports and shipping sector has the opportunity to grow if infrastructure can be enhanced with foreign investment.

The commitment from government to monitoring and regulating the utilization of the country's natural resources highlights the potential for improvement in management regimes. By harnessing the country's rich biodiversity and promoting future sustainable development, the coastal zone has the potential to not only diversify it's economy, but also create spillovers that could promote alternative streams of income in the process. For example, the development of a mariculture sector has the potential to not only help compensate for the over-exploitation of fisheries resources, and increase employment opportunities, but could also potentially promote the development of eco-tourism. Likewise, by promoting investment in a sustainable agriculture and forestry sector, not only could forest degradation be slowed down, but opportunities for organic, food-based agriculture could be promoted. This has the potential to both reduce costly foreign imports, as well as diversify the economy and again create alternative streams for income generation.

The willingness of government to empower local communities in relation to their natural resources is also a positive sign moving forward. Whether it's with capacity-building in the small-scale fisheries or training in sustainable agriculture techniques, both the Comoros government and the relevant international organizations have committed to devolving knowledge and capacity to the coastal communities whose lives depend on their natural resources.

Overall, while infrastructure, political instability and the over-exploitation of natural resources present many challenges in the Comoros coastal zone, the commitment to sustainable social and economic development at the community level is high. As long as political stability prevails, business opportunities can be promoted across sectors, and investment, employment and economic growth has the potential to flourish. This, in turn, has the potential to decrease the country's dependence on volatile commodity exports and subsequently revitalize the socio-economic status of the Comoros coastal zone.

## 5. Policy and Governance

*A comprehensive report was prepared on Policy and Governance, which is Annex IV to this MEDA.*

The Comoros has experienced political and institutional crises that have prevented the country from experiencing political stability that is necessary for creating ideal conditions for socio-economic development. The dual political-institutional crisis started with the secession of the island of Anjouan in 1997 which introduced a new governance structure for the country. A new federal constitution was passed in December 23, 2001 and revised in May 2010. Presidential elections are held periodically, allowing the implementation of the rotating presidency at the national and islands levels. A National Assembly and the Assemblies of the autonomous islands are in place. However, lack of clear definition of powers of these institutions leads to jurisdictional conflicts on the prerogatives of autonomous entities and the Union Government. However, it is important to note that democracy has started to be entrenched in the Comoros and the socio-political concerns and the expression of the people through elections are increasingly being respected and recognised. The majority of the public have recognized the need to improve governance in the Comoros since this is essential for the country to make significant progress in economic development.

### 5.1 Administrative regions on land (coastal districts, municipalities)

The revised constitution of May 2010 gives some autonomy to the islands. Each island is administered freely within the limits of the powers conferred upon it. The institutions of the islands are the governors and council of the island. The governor is elected by direct universal suffrage. It provides, on the island enforcement of the Union of Comoros, promulgates the deliberations of the Council of the island and ensures the implementation of its decisions. It also exercises regulatory power in matters within the jurisdiction of the island such as appointment of the chief administrative officer of the police force, appointments to the island and supervises local authorities. It is represented in the regions by the prefects. The governor is assisted by commissioners. The governor is also supported by a council of the island, elected in each electoral district by popular vote. The governor votes for the law in all matters except those subject to the constitution of Union. Since September 2011, the decentralization law was passed by the National Assembly. It introduces the municipalities and territorial division. The next municipal elections are scheduled for 2012.

### 5.2 Administrative/legislative zones of the sea

The institutional framework for the management of the environment of the Comoros includes national and island representatives. At national level, issues concerning the environment are managed by the National Directorate of Environment (DNE), the National Institute of Applied Research of Fisheries and Environment (INRAPE) and almost all the Ministries (Ministry of Public Finance, Budget, Economy and Planning; Ministry of transport and Tourism; Ministry of Planning and Housing ; Ministry of Public Health and Population ; Ministry of Education; Ministry of Justice, etc). Each island has regional departments of the Environment and the various departments of the autonomous islands established as per the requirements of the new constitution. The responsibilities include the enforcement of regulations protecting the natural environment. Lack of capacity has, however, lead to failure to control widespread degradation of marine and coastal environment. The new situation created by the implementation of the decree on decentralization should encourage new decentralized institutions to become fully involved in the formulation and implementation of activities for sound management of marine and coastal resources. Actions developed and/or micro-projects or priorities identified by the prefectures and municipalities must be adapted to this new governance configuration in order to involve the most peripheral levels and therefore reach the target beneficiaries.

### 5.3 Legislation

The constitution of the Union of Comoros has endorsed environmental concerns: it explicitly calls for the protection and conservation of natural and cultural heritage. The development of a national policy on the environment has embodied the commitment of the Government of the Comoros to address the problems of environmental degradation. In particular, the policy reinforced the Government's objectives of integrating the environmental dimension in politics and socio-economic development of the Comoros. The government also registered its action towards the achievement of Goal 7 of the Millennium Development Goals (MDGs), namely to ensure environmental sustainability by integrating the principles of sustainable development into country's policies and reverse the loss of environmental resources.



A framework law on the environment was adopted October 6, 1994 by the Federal Assembly and promulgated by the President of the Republic (Decree n0 94/100/PR). This law aims at adapting the current legislation on the environment by taking into account current concepts such as sustainable development, impact studies, biological diversity, protecting the Earth's environment and marine protected areas. It also lays down the general principles which should inspire and guide the regulation of activities that may harm the environment. It has three main objectives which include; the preservation of diversity and environmental integrity in the Comoros, the creation of conditions for sustainable use of natural resources for future and present generations and the guarantee to all citizens environmentally sound and balanced living. Under this law, the protection regime is stricter for endemic, rare or endangered plant and animal species whose conservation is important for the balance of nature. The Act also devotes a large part on the creation of parks and nature reserves in the country. It sets out the terms for their classification, their boundaries and management structures. Comorian political authorities have also engaged in a policy of sustainable management of these resources in view of very high population pressure and the small size of arable land.

#### **5.4 National, provincial and local authorities in coastal/marine affairs**

At national level, issues concerning the environment are managed by the National Directorate of Environment (DNE), the National Directorate of Fisheries, the National Institute of Applied Research Fisheries and Environment (INRAPE) and almost all the Ministries (Ministry of Public Finance, Budget, Economy and Planning; Ministry of Transport and Tourism; Ministry of Urban planning and Housing; Ministry of Public Health and Population; Ministry of Education, Ministry of Justice, etc). At the island level, regional departments of the environment ministry and the regional fisheries commissions are found whose responsibilities include the enforcement of regulations for protecting the natural environment and fisheries, among others.

#### **5.5 NGOs / private sector**

The voluntary sector is well developed in the Comoros. Each village has one or more associations that are the basis of a series of initiatives undertaken in many areas. These associations are often born under the impulse of people to undertake voluntary cultural activities, health, environmental, or musical activities. Cities and villages create voluntary associations for environmental protection. People organize themselves, often without external support to implement their skills and knowledge to take care of their natural resources and environment while meeting their basic needs. Some NGOs specialising in environmental management have emerged in recent years but are generally in their early development stage because of lack of qualified human resources. These NGOs include Action Comores, Association of Intervention for Development and the Environment (AID), Action for Sustainable Development and Environment (ADDE), COMOFLORA, and others. The National Network on Women and Development has within it a cell focussed on communication and health. The private sector is gradually organizing itself through organizations such as the employers' organization of the Comoros, the Chamber of Commerce, economic interest groups or other business organizations. Although the main activity is trade and business, the private sector in Comoros is becoming more and more involved in the agricultural, fishing and tourism sectors.

#### **5.6 International relations, conventions and committees**

The Comoros is party to a number of international multi-lateral environmental agreements and conventions. The country has also taken onboard the obligations of the United Nations Conference of 1992 on Environment and Development (UNCED). The country is party to;

- United Nations Convention on the Law of the Sea (UNCLOS) adopted at Montego Bay December 10, 1982.
- Ramsar Convention on Wetlands of International Importance especially as Waterfowl Habitat, adopted February 2, 1971. Ratified by Decree No. 94-007/AF of June 6, 1994
- Convention Concerning the Protection of World Cultural and Natural Heritage, adopted in Paris on 23 November 1972. Ratified by Decree No. 94-008/AF of June 6, 1994
- Washington Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), adopted at Washington, December 29, 1972. Ratified by Decree No. 94-005/AF of June 6, 1994.
- Vienna Convention for the Protection of the Ozone Layer, adopted in Vienna March 22, 1985 and the Montreal Protocol on Substances that Deplete the Ozone Layer of 16 September 1987. Ratified by Decree



No. 94-011/AF of June 6, 1994.

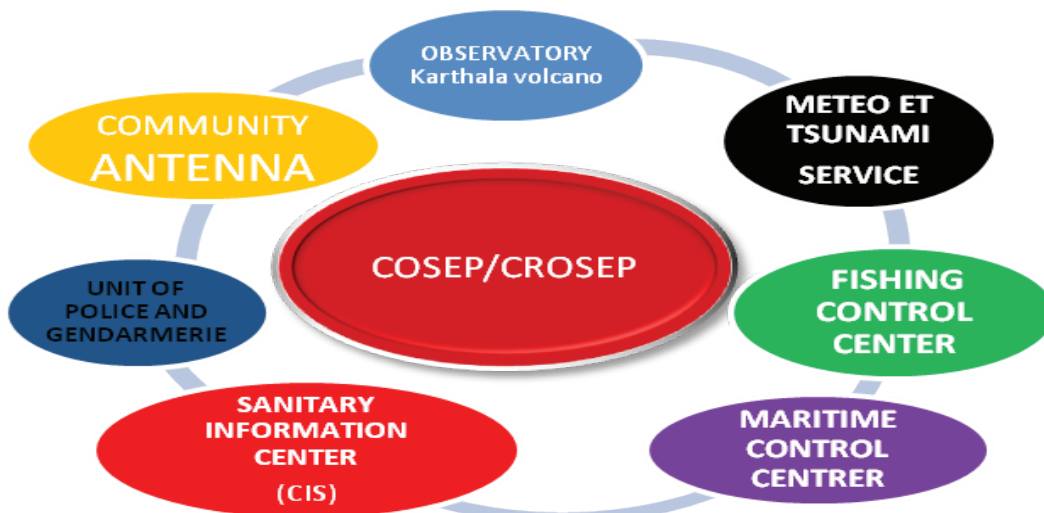
- United Nations Framework Convention on Climate Change, adopted in New York May 9, 1992. Ratified by Decree No. 94-010/AF of June 6, 1994.
- Convention on Biological Diversity (CBD), adopted in Rio de Janeiro June 5, 1992. Ratification August 30, 1994.
- Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, adopted in Basel, March 22, 1989. Ratified by Decree No. 94-009/AF of June 6, 1994.
- Convention for the Protection, Management and Development of Marine and Coastal region of Eastern Africa, adopted in (Nairobi in 1985. Ratified by Decree No. 94-012/AF of June 6, 1994.
- Convention on the Fight Against Desertification, adopted in Paris on 17 June 1994.
- Stockholm Convention on Persistent Organic Pollutants (POPs)

## 6. Planning and management

Unlike many countries, neither the constitution of the Union, nor the constitutions of the islands refer to a state of emergency to allow authorities to take exceptional measures during a crisis or catastrophe. Thus neither the Union nor the Islands have comprehensive laws on the management of risks and disasters. However, a high-level National platform brings together key players from the government, the Comoros Red-Crescent (CRCO) and the civil society to discuss disaster management. The Emergency Operations and Civil Protection Centre (COSEP) is the executive body. The Comoros have developed several operational plans to deal with disasters, per sector or specific (Karthala, cyclone, marine pollution- MARPOL, HIV/AIDS, bird flu, etc.) as well as the National Emergency Preparation and Response Plan and the National Contingency Plan.

### 6.1 National disaster management plans

The Union of Comoros is prone to natural disasters. Risks related to natural disasters are numerous and pose serious threats from the perspective of sustainable human development in the Comoros. They relate in particular to geophysical disasters such as volcanic eruptions of the Karthala volcano on Grande Comore, cyclones, floods, and tsunamis. In recent years, the frequency and magnitude of cyclones has increased due to climate change. There is also risk of oil spill disaster since the islands are situated on the oil tanker route. However, the Union of Comoros lacks capacity to sufficiently respond to a major oil spill event. The country prepared the National Plan for Preparedness and Emergency Response in 2003, with support from the UN system in the Comoros. This Plan which was updated in November 2007 focusses on strengthening national capacities in disaster management and the establishment of the national platform for disaster prevention and management. The overall objective of the Plan is to provide national authorities and partners a reference tool for better preparation and management of emergencies. It focuses on the analysis of the situation, guiding principles and strategies and planning and sectoral responses. Sectoral plans relating to the preparation and management of emergencies such as volcanic eruptions, coastal erosion, the tidal wave, safety, pollution and sea rescue, serious traffic accidents, epidemics, fires, cyclones and other emergency organization plans, are an integral part of this plan. The Operations Coordination and Emergency Preparedness (COSEP) centre is responsible for coordination and implementation of this plan. COSEP is under the General Directorate of Civil Security.



**Figure 26. National Emergency Preparation and Response Plan**

In this National Emergency Preparation and Response Plan (Figure 6), the accepted operational definition of urgency is: a situation for which there is consensus that extraordinary action beyond the routine programs and systems is required to ensure the protection of basic rights, the survival and the well-being of the affected population. Several types of situations can be considered emergencies:

- a) On-going silent emergencies (e.g. economic crisis, absolute poverty, diseases that can be prevented, malnutrition, poor education, abuse)
- b) Natural disasters

## c) Man-made emergencies (e.g. conflict, civil unrest, governance crisis)

The Union of Comoros is a country prone to emergencies, not yet sufficiently organized to prepare for and respond to emergencies in a consistent manner. This Plan, updated in November 2007, is the culmination of efforts over the past year by the central executives and by the islands of different sectors, with support from the United Nations System in the Comoros. The overall objective of this Plan is to provide the national authorities and their partners with a reference tool allowing them to better prepare for and manage emergency situations.

Sector plans relating to the preparation and management of emergencies linked to: volcanic eruptions, erosion, tidal waves, safety, marine pollution and sea rescue, serious road accidents, epidemics, fires, cyclones as well as the other emergency organization plans, are an integral part of this plan. On a national level, during the initial phase, the coordination unit is made up of:

- The Ministry in charge of the affected sector as Chairman of the Coordination
- The Chief of Staff or his representative
- The Director of the Emergency Operations and Civil Protection Centre (COSEP)
- The technical manager of the sector concerned
- A representative of the Presidency of the Republic
- A representative of the Islands
- A representative of the national media

In practice it is the Minister, the Chief of Staff, the Director of COSEP and the Technical Manager who will meet. At the institutional level the Plan states that risk and disaster management is carried out by four agencies.

The strategic body of COSEP responsible for overseeing, coordinating and monitoring the development and implementation of the national strategy for risk and disaster management

The executive body of COSEP responsible for monitoring and early warning as well as the overall coordination of preparation activities and the operational coordination as a whole

The institutions and organizations in charge of monitoring and warning as well as operations: specialized units of the Armed Forces, the Gendarmerie, the Police and the Red-Crescent

Ministers and agencies involved with structural rehabilitations

The Comoros only established an institution for disaster coordination in 2007 by the Decree No. 06-51/PR of 2006 on the creation of an Emergency Operations and Civil Protection Centre (COSEP). The mandate covers all aspects of the coordination for preparation, response and prevention during a crisis. COSEP's strategic coordination and operational coordination duties, from national to local level, are defined in this national plan. The existing coordination system in the Comoros should cover all types of emergencies of national importance. At the operational level, the emergency preparation and response plan provides for two additional structures which have so far never been mobilized.

The Fixed Command Post is the central command centre that brings together the experts and policy makers of all the stakeholders of the National Emergency Preparation and Response Plan. It consists of COSEP and five units and is located in the Ministry of Defence. It coordinates the preparation, response and rehabilitation activities of all the players, including the actors of each sector. The role of the units is to define the most urgent needs, to assess the resources needed and to support rescue operations in their respective fields: transmission, rescue and logistics, information.

The Mobile Tactical Command Post is placed under the supervision of the authority of the autonomous island. It has an executive body, the Regional Emergency Operations and Civil Protection Centre (CROSEP). As the permanent executive body on the island, CROSEP is COSEP's direct correspondent. As such it receives delegation of COSEP's powers in emergency preparation and response. It consists of the Minister for Home Affairs (Chief of Operations), a military authority, the Head of CROSEP, a representative from each operational unit including NGOs and Red-Crescent. It has five teams whose role is to support field operations: Reconnaissance and securing team, Evacuation team, Health team, Accommodation team, Technical crew and maintenance team.

COSEP and CROSEP should also provide a central role in the coordination between the sectors as defined by the plan. However, gaps were identified in the management of emergency situations that are particularly related to the absence of the following elements, symptomatic of the country's state of development:

- A clear institutional framework
- Monitoring policy
- Raising awareness of disaster risk
- Tailored training
- Infrastructure and human resources
- Studies on the risk and vulnerability to cholera and tropical disturbances

In addition, it is also noted in these risk management plans that implementation remains a major challenge due to the inability of the operational units (no means of first response), the absence of certain emergency plans (evacuation, Tsunami, fire rescue, etc.), the absence of simulation exercises, the lack of information management and communication, the lack of public awareness and of institutional actors, as well as the lack of scientific research outside Karthala are all aggravating factors and disabling in the organizing of an effective response in case of a disaster.

COSEP established a Centre for Information Analysis and Processing (CATI) and a Geographical Information System (GIS) to compile information relevant to the emergency preparations and responses. CATI plans to set up a geo-referenced database as well as vulnerability and evacuation in case of emergency maps. A variety of information is collected in different formats and over different periods and is managed by different organizations at different levels: National, Islands, Regional District. The information on natural hazards can be found at the Volcano Observatory, the General Directorate of Meteorology and the National Department of Health, particularly in the health information system. There is no standard for the collection and compilation of different types of information.

Communication between the ministries of the Union and their relevant ministries on the islands, between the regions and the communities is generally based on personal contact and not on a specific communication protocol, thus making the flow of information uncoordinated. The telecommunications network in Comoros is mainly commercial. Some emergency numbers are free. There are two mobile networks (GSM and CEDEMA), covering 80 to 85%, as well as a fixed network. The means of communication in Comoros are mainly telephone booths available and operational in all the villages of the three islands. The introduction of a fibre optic network is underway in Comoros. High Frequency (HF) radio communication is used by some UN organizations and agencies and some NGOs as a means of communication.

### **National Contingency Plan**

The national contingency plan has been developed with the support of the United Nations System and the risks and disasters management of all sectors involved in the government and society. However, all response operations are centralized at COSEP that will call up the actors, according to the crisis occurring (flood, cholera, etc.), to organize the response. The existing coordination system in the Comoros is unique in its composition for all disasters or events of national importance. On a national level, during the initial phase, the coordination unit is made up by:

- The Ministry in charge of the affected sector as Chairman of the Coordination
- The Chief of Staff or his representative
- The Director of the Emergency Operations and Civil Protection Centre (COSEP)
- The technical manager of the sector concerned
- A representative of the Presidency of the Republic
- A representative of the Islands
- A representative of the national media

However, the evolution and speed of the situation means that in practice it is the Minister, the Chief of Staff, the Director of COSEP and the Technical Manager who will meet. This restricted committee decides, on the basis of information from COSEP and or from the affected sector, on the evolution of the situation. During the implementation of the contingency plan, the operations management is done by the Minister of Defence

and National Security or the acting authority. The Strategic Coordination Centre will be housed in the Office of the Minister of Defence and National Security. The Operations Centre will be located at COSEP. The contingency plan is implemented if the situation exceeds the capabilities of the local actors or if it calls upon state officials and external partners.

At the autonomous islands level, the Ministries of Home Affairs are responsible for activities related to the preparation and response to emergencies. A coordination structure similar to that of the national level is established for the implementation of tasks and responsibilities under insular authority. An organizational chart defines the tasks and responsibilities.\_

### **Institutional Organisation**

At the institutional level, risk and disaster management is carried out by four agencies:

The Emergency Operations Division brings together all the decision makers and experts. It is the strategic body for supervision, coordination and control, development and implementation of the National Strategy for risk and disaster management. It is placed under the authority of Minister of Defence and National Security.

The National Emergency Operations and Civil Protection Centre (COSEP), is the Permanent Executive body of the Emergency Operations Division and is in charge of:

- Monitoring and early warning
- Centralization, analysis and information processing
- Prevention
- Organisation and resource management
- Facilitating communication between the different sectors
- Operational coordination of the actions of all governmental or nongovernmental actors
- Coordinating the development, updating and activation of the different risk and disaster management plans

The Divisions, Training and Specialized Centres, in charge of monitoring and warning as well as operations:

- The Division of Civil Protection, in charge of training (administration and actual training):
- Specialized Civil Protection Training
- Specialized training of the armed forces, the Gendarmerie and the Police
- The Red-Crescent, associations and community organizations
- Institutions empowered to ensure monitoring and triggering warnings according to procedure
- The Ministries and agencies involved in structural rehabilitation

### **Information Management**

COSEP and its operational partners will play an important role in the establishment of reliable and accurate information systems needed for better decision making.

### **Activities**

Collect and analyze all necessary information from the press or other sources of information,

Appoint the person(s) authorized to speak to the national and international media,

Establish and update the press and national and international media contact list,

Prepare and distribute the most appropriate information of the situation and the needs following the crisis to the media,

Organize daily press conferences/briefings (or when necessary) on the national response and the evolution of the situation.

### **Public Information**

COSEP base their communication strategy on direct interaction with the focal points identified by the Comorian Government, the United Nations System, the donor community and the NGOs. The main target of the communication strategy will be to apply the basic principles for humanitarian action and to highlight the needs of the affected population.



The national and international media will be regularly informed of the various actions identified by the Comorian national coordination.

### **Resource Mobilization**

In the event of a crisis or in anticipation of this crisis, the partners identify potential donors to mobilize resources. For many donors and partners emergency funds and external support can only be allocated after a state of emergency or disaster has been declared and a request for international assistance launched by the Government. To prevent the process of resource mobilization being delayed by a late state of emergency or disaster declaration, the Government of the Union of Comoros can make a specific or geographically limited declaration.

After an eventual state of emergency declaration by the Union of the Comoros Government, a «Flash Appeal» may be prepared. The humanitarian community in the Comoros has different tools for joint resource mobilization, including:

- **The Flash Appeal:** this is a process for mobilizing emergency funds led by the Resident Representative of the United Nations System and the humanitarian community in the country. Based on a needs assessment. The Flash Appeal, including the project files (CAP template) for immediate response to sudden emergency, is launched by the Emergency Rescue Coordinator (ERC) and presented to the donor community.
- **The Central Emergency Response Funds (CERF):** presented as one of the four pillars of Humanitarian Reform, CERF is a humanitarian fund for emergency response administered by OCHA. CERF has 500 million USD per year, available under the Rapid Response component or Under-funded Emergencies. Following the emergency declaration, the Resident/Humanitarian Coordinator and the humanitarian community can prepare an application for funding based on assessed needs and whereof the activities/projects meet the funding criteria to “save lives”.
- **The Consolidated Appeals Process (CAP) Western Africa 2008:** This is the continuation of the Flash Appeal to ensure a response spread over 12 months.

### **Safety and security of staff and resources of the United Nations**

The safety and security of the population and the humanitarian actors remain the responsibility of the Comorian government. Nevertheless, the United Nations Agencies, via the Resident Coordinator and UNDSS, may also activate their security and emergency safety of personnel and resources plan. The overall objective of the contingency plan is to assist the Comorian government to implement a real-time and coordinated response in order to minimize the humanitarian consequences of disasters on the population. The following strategic objectives form the core interventions planned under this contingency plan:

- Provide assistance and adequate protection to the population affected by the disaster.
- Establish appropriate mechanisms to mobilize resources to meet the immediate, medium and long term needs of the population's vulnerable groups.
- Provide adequate security for the actors and beneficiaries.

### **Monitoring and Early Warning**

The monitoring of the Karthala Volcano's seismic activity on Grand Comoro is ensured by the Karthala Volcanic Observatory (OVK), which gives early warning of abnormal activity. A three level alert system exists (yellow, orange, and red). There are eight seismic stations to monitor the volcanic activity whereof six is the absolute minimum to provide key information on volcanic activity. These stations provide information on magma movements within the volcano and indicate periods of increased activity. The OVK has frequent contact with Reunion's Volcanic Observatory, but not with any other observatory. As for cyclones and tsunamis, the Meteorology Department is the focal point. Weather reports are sent to the three islands' airports via internet. At the start of the cyclone season (November to mid April) the Meteorology Department sends a notice to the media to remind the public of the measures to take in order to prepare for cyclones. Maritime and aviation security and monitoring is the responsibility of the Department of Transport. Maritime and oceanographic surveillance is a priority for many state departments with distinct objectives. Two boats were acquired by the Union of Comoros to participate in maritime surveillance and search and rescue operations at sea. Information transmission lines, including the decision to trigger the alert, remain unclear. The Ministry of Defence is the competent authority to trigger the alert, after consultation with COSEP, but these consultations may delay launching the different interventions. Public alerts are broadcasted through the media and VHF and UHF

radios. Police and gendarmerie units, the mosques, the Comoros Red Crescent and community groups are responsible for spreading the word of warning to the population. Megaphones, speakers, flags (orange and red as an OVK warning) and manual sirens are used to gather the population and provide them with information on how to act and what actions to take.

### **National Action Plan against Oil Spills at Sea**

Offshore oil activities are mainly composed of exploration, production and petroleum transportation by sea. The accidental oil spills caused by oil tankers or other vessels can cause serious pollution of the marine environment and could have a significant impact on the environment and socio-economic activities of the islands of the archipelago of the Comoros. According to the sub-regional context, it is estimated that about 700 million tons of crude oil annually pass through the waters of the Indian Ocean Islands to Europe, Asia and America. Statistics also show that most of the oil tankers pass through the Mozambican channel and represent 1,200 large tanker (<250,000 Tonnes) trips per year and 4 000 medium-sized tanker (60,000 Tonnes) trips. Given the number of oil tanker passages and the size of these vessels engaged in maritime traffic around our shores, the risk of oil pollution exists and the possibility of accidental pollution cannot be ignored on the islands. Also, the cyclone season is liable to increase the risk of maritime accidents thus causing marine pollution. Aware of the risks and economic and ecological impacts of accidental oil pollution, the development of national and local action plans were necessary in order to be ready to cope with this threat. The Comorian government decided to establish a preparation and response in case of accidental pollution plan as well as to acquire specific control equipment. The National Action Plan against Oil Spills at Sea defines the administrative organization and intervention technique at sea and along the coast as well as the identification of responsibilities of the parties involved and their respective companies.

The plan states that each autonomous island must imperatively have a local action plan, compatible with the general provisions of the National Plan, but specific to local conditions, allowing the implementation of control operations and crisis management at local level. The control responsibility is at the level of the autonomous islands. The National Level is responsible for the overall resource coordination of the Union and External Relations (spreading of information, obtaining regional or international help, compensation and participation in the sub-regional action plan). Following the worldwide recommended methodology, three levels of importance of oil spills are defined. They also determine the level of intervention:

- Level 1: For small-scale pollution that can be treated with CROSEP's own resources and the resources of a Coast Guard unit
- Level 2: For medium-scale pollution that cannot be treated with CROSEP's own resources and that of a Coast Guard unit alone, but must also use all the available resources on the island. The local action plan is triggered
- Level 3: For large-scale pollution that requires resources not available on the island and may eventually require an appeal for international help. The local and national action plans are triggered

Thus the national action plan will only be triggered in the following cases:

- For large-scale pollution
- When the sub-regional action plan is triggered by another country in the area

The Union of Comoros National Plan identifies the roles and responsibilities of different national bodies, both to prepare for the struggle and for the management and implementation of control operations in case of pollution.

### **6.2 Environmental sensitivity mapping**

Due to lack of capacity, vulnerability mapping has not been undertaken for the Comoros. However, areas of high sensitivity to climate change are known. Also, sensitive ecosystems extremely vulnerable to human pressure and pollution are also known.

### **6.3 Coastal Management and Development Plans**

The Comoros are currently in the process of setting up and developing an Integrated Coastal Zone Management (ICZM) Plan. A National Committee for Sustainable Development (NCSD) has been established. It includes

aspects related to the sustainable management of coastal areas. The Committee's primary function is to contribute to the development of a national Integrated Coastal Zone Management plan. This plan will consist of a scheme of land use zoning and housing incorporating all aspects of coastal resource management. Special emphasis will be placed on the control of coastal erosion due to sand mining for construction purposes and the development of eco-tourism.

### 6.3.1 Integrated Coastal Zone Management Plan (ICZM).

The Union of Comoros has a total surface area of 2,236km<sup>2</sup>. The exclusive economic zone is estimated at more than 160 000km<sup>2</sup> and covers 900km<sup>2</sup> of continental shelf and 427km of coastline. The population of the Comoros was estimated at 670 000 people in 2009 and will reach 785 000 in 2015, a rapid population growth resulting in enormous pressure on coastal areas and forests. At Ndzuwani the population densities are reaching critical levels as in the region of Nyumakélé where they exceed 500 inhabitants per arable square kilometre. On Mohéli the Anjouan migration's search for farmland is destroying the forest. This means that the current environmental degradation problems may worsen if the country fails to take timely and appropriate action to address this demographic change. Moreover, the country's biological diversity and richness contrasts sharply with the poverty of its inhabitants. Indeed, the Comoros has one of the lowest gross national product per capita in the world (315 USD), a very high population density and population growth (2.1% per year) as well as an economy largely based on international aid and the export of cash crops of which the value continues to decrease regularly.

Due to the high population density (300 inhabitants/km<sup>2</sup>), the lack of land use planning and land tenure policy, the environment is the subject of major anthropogenic pressure: including for example, deforestation for agricultural purposes resulting in the gradual silting of coral reef flats, the extraction of beach sand for construction, overexploitation of coastal fisheries resources, the exploitation of endangered species, the use of destructive fishing techniques and discharging domestic waste into the marine environment.

The Union of Comoros, aware of the extent of its environmental degradation and its impact on increasing poverty, has taken many initiatives to reduce on the one hand and on the other to promote the value of their natural resources and this in spite of their limited human and financial resources. For illustrative purposes we can mention:

- The development of the national environmental policy as well as an Environmental Action Plan (EAP)
- Development of an environmental framework law as well as strategies and action plans per sector
- The ratification of several international environmental conventions in the spirit of taking part in global efforts for environmental protection and population well being
- The development of the PRSP (Poverty Reduction Strategy Paper), which takes into account the environmental dimension in general and especially the dimension related to coastal zone management, through its main lines and intervention programs

This national plan for sustainable coastal areas management, developed as part of ReCoMaP, will also serve as the national action plan within the regional strategic action plan against land-based pollution activities and sources developed by the Nairobi Convention in the WIO-LaB project.

The Union of Comoros does not have an environment policy per sector, but rather a national environment policy developed following the United Nations Conference on Environment and Development (Rio, 1992) and the consultation meeting on the Comoros development program (Jeddah, 1993). This policy reflects their commitment to appropriate the concept of sustainable development and to act to protect the environment; the environmental diagnosis made in 1993 was really damning. The basic principle behind the policy is to take into account the environmental dimension in all policies of socio-economic development. This principle's objectives are to ensure rational and sustainable resource management and to define and strengthen a policy per sector.

To implement the national environment policy, the country also established an Environmental Action Plan (EAP) which defines the priority actions and programs as well as the resources to mobilize. Moreover, the Union of Comoros, consistent with the objectives of the Millennium's Development Goals (MDGs) developed a Growth and Poverty Reduction Strategy Paper (GPRSP) in 2005, which was updated in 2009. It thus

provides the reference for the socio-economic development of the country by defining the country's development priorities. Seven strategic areas of intervention are defined.

In legal terms, it should be recalled that the Union of the Comoros adopted a framework law on the environment in 1994, as legal framework associated with the implementation of the environmental action plan. This Law, amended in 1995, contains no specific provisions for the management of coastal resources, but rather general principles on all the aspects of environmental protection such as pollution, impact studies, terrestrial and marine environment protection, protected areas etc. The framework law is the basic legal text governing environmental issues in general and the main inspirational source for other regulatory texts. Indeed, in reference to this law, specific decrees and orders were established, among others, the decree on impact studies, the decree on quarrying, the decree on coastal zone monitoring as well as orders on the protection of the mangroves, the harvesting of sea cucumbers, the protected areas and the extraction of sea sand and corals.

Some texts prior to the framework law on the environment, regulating some aspects of coastal management are still in force in spite of their ancient character. This concerns on the one hand the decree of 1926 and the order of 1958 relating to the demarcation of the public domain and on the other hand, regulations on the so-called «geometric step». The area of the «geometric step» is an 80m wide strip of land starting from the line marking the highest level of sea water, rivers and lakes. It belongs by law to the state which should regulate its occupation.

In addition, on 17 September 2007 Law No. 07-011/AU on the fisheries and aquaculture code of the Union of Comoros was enacted. This law fixes the operating rules of fishing and aquaculture in order to ensure the sustainable management of fisheries resources. While it is specific to fishing, the law has a significant impact on coastal zone management.

### **6.3.2 Multilateral agreements, international conventions and protocols**

In 1994 the Comorian government adopted the Declaration on Sustainable Development which recognizes the principles of community participation in national development and the fundamental nature of the link between sustainable development and sound management of natural resources. They therefore committed to develop instruments to manage their environment, such as the national environment policy and the environmental action plan. To confirm their commitment and implement their policy, they also ratified protocols and committed to several international conventions on the environment, some of which have direct or indirect implications on the management of coastal areas.

## **6.4 The institutional framework linked to integrated coastal zone management (ICZM)**

### **The main actors involved in ICZM**

The principle of community participation in the country's development behind the Declaration on Sustainable Development of 1994 has encouraged the emergence of two main types of actors i.e. state actors and non-state actors.

#### **State actors**

Since the adoption of the national policy and strategy for agriculture and environment, the Comorian government has initiated a program of institutional reform of the supervisory ministry with the aim of creating an institutional framework adapted to the new guidelines for Sustainable Development. At present this organizational framework is declined as follows:

#### **At national level**

At country level this is the department responsible for environmental issues; its primary mandate is to design, coordinate, monitor and evaluate the national environment policy.

The Directorates and Departments within the ministry generally in charge of environmental issues are:

**The National Directorate in charge of the Environment and Forests:** It is the main administration responsible on a national level for environmental management. Its primary mandate is to ensure the implementation of the



policy and environmental action plan.

**The National Research Institution for Agriculture, Fisheries and Environment (INRAPE):** Created by the Law No. 95-09 of June 20, 1995. With its administrative bodies and support services, it is mandated to design and conduct research programs and studies in the fields of agriculture, fisheries and the environment.

**The GIS Department:** Created April 21, 2007 by Order No. 07/13/MAPE/CAB of the Minister of Agriculture, Fisheries and Environment. Its mission is to 1) enhance the achievements of projects by building geographical information systems 2) lay the groundwork for an information system and decision support system for sustainable development

**The National Directorate of Fisheries Resources:** Acknowledges, among other mandates, the formulation and implementation of national policies for sustainable management of fisheries resources.

**The National Directorate of Agricultural Strategies:** Responsible for contributing to the design and implementation of agricultural policies that respect the concept of sustainable development.

On the national level, in addition to the Ministry of Environment, other ministries and institutions are also involved, directly or indirectly, in the environment sector. They are:

**Ministry of Public Finances,** the budget, Economy and Plan. Principally involved in the mobilization and provision of funds.

**Ministry of Transport and Tourism** responsible for setting the tourism development policy in the country through the General Tourism Directorate.

**Ministry of Planning,** urban planning and housing in charge of the country's infrastructure.

**Department of Public Health and Population** via its department in charge of hygiene and sanitation as well as the epidemiological surveillance service in charge of monitoring environmental factors determining epidemics and endemic diseases.

**Ministry of Education** through IFERE on the one hand, the Faculty of Science and Technology of the University of Comoros, which provides formal environmental education and ecology classes and on the other hand, the National Scientific Research Centre (NSRC) established on January 11, 1979 and featuring a range of very diverse scientific activities.

**Ministry of Justice** responsible for the implementation of laws and regulations of the Republic.

The **Plan's General Board/Commission** responsible for planning, coordinating and ensuring the monitoring and evaluation of the country's development activities.

### At island level

Under the new institutional framework of the country, each island has its own executive insular power made up of commissions composed of general directorates, including the general directorate of environment. Their mandate is to contribute to the development of national policies and their implementation at island level.

### Non-state actors

Faced with the general threat to the environment and the principle of community participation in the country's development, many initiatives have led to the creation of associations and national NGOs working for environmental protection. Thus, on a national and insular level one can distinguish the following main structures:

- **The Ulanga Associations:** They exist in most villages, on Anjouan, Grande Comoro and Mohéli and have contributed greatly to the collective awareness of environmental issues.
- **The Gombessa Protection Association (GPA):** Its main ambition is the sustainable development of the Comoros Islands, based on the protection of the coelacanth *Latimeria chalumnae* and its marine and coastal environment.
- **The Ndudju Association:** It is an association from Chindini village in the south of Grande Comoro, the Megaptera Indian Ocean NGO's affiliate. Its main activities are the education and training of fishermen and whale observations with tourists.
- **The AIDE NGO (Intervention for Development and the Environment Association).** It was created on November 10, 1977 and governed by the law 1901. Its mission is to contribute to the sustainable development of the Comoros through environmental protection activities and studies within the area/sector.
- **The Anjouan HTC NGO:** The HTC group was created in 2003 on the island of Anjouan by young



professionals working in sustainable development and trained in marine environment study techniques by the national network of coral reef monitoring. It works in several areas including the management and protection of marine resources and monitoring the health of marine ecosystems.

- **The Comoros Anjouan Action NGO:** It aims to contribute to public awareness of sustainable management of the environment.
- **The Management Committee of the Marine Park of Mohéli** in which a responsible of each village and representatives of the administration are present. The committee defines the principles that should guide the action of the Park's management team. The management team, very close to the village communities, takes care of the park's daily management: surveillance, scientific ecosystems monitoring, community participation management, information and awareness of the population.
- **The house of Mohéli ecotourism** was created in September 2004. It is the unifying structure of all the tourism stakeholders on the island. It supports communities to develop eco tourism activities and promotes ecotourism in general.
- **The community based organizations (CBOs):** On the islands local community organizations working to protect the environment in general can be found in most villages.

### **Institutional Strengthening**

In order to strengthen the partnership between all stakeholders and contribute to the harmonization of their interventions, for more efficiency, an environmental dialogue and consultation body was established at national level. This body is known as the «National Commission for Sustainable Development (NCSD)» was created by the Order No. 001/MAPE/CAB of March 10, 2008. It has no specific mandate for ICZM but rather a global mandate to ensure that the environmental dimension is taken into account in the programs and sector development policies. On the islands, the NCSD is relayed by the Insular Committees for Sustainable Development (ICSD). Their creation is the responsibility of the island's Commissioner in charge of the environment. The island ICSD are set up and exchange and share information with the NCSD which in turn informs the government through the Secretaries General forum and on a regional level via the available sites and addresses.

Regarding functional aspects, the NCSD does not have a fixed budget for its operation and its mission but receives various ad hoc aids from some partners. Some agreements in principle are also provided by partners such as the WIOLAB program, the ReCoMaP program and the ASCLME program to financially support the NCSD in the performance of its specific missions and the consolidation of its existence. The ANCAR project calls for institutional support actions to the NCSD, which could include financial support.

### **6.5 Areas under special management**

Moheli Marine Park was the first protected area in the Comoros. It was created by Decree No. 01-053/CE signed by the Head of State in April 19, 2001. It provides a zoning of the area south of Moheli into a national park under the provisions of Article 46 of the Framework Environmental Act. It covers an area of 404 km<sup>2</sup> including the southern coast of Miringoni Itsamia to the Nioumachoi and a large area of open sea. Although the park is supervised by the government, it is the local association that runs it on a daily basis. Fishing is completely banned in some areas of the park and in some areas fishing of certain species is permitted. Any violation of the regulations is handled directly by a committee of villagers and the case is transferred to a national judicial system when local solutions could not be found.

### **6.6 Monitoring, Control, Surveillance**

Monitoring, control and surveillance is provided by the Monitoring and Evaluation Unit of the Ministry for the Environment and Fisheries and Monitoring Unit of the National Fisheries Management Authority. The Union of Comoros has received support from many regional projects for monitoring, control and surveillance of marine and coastal ecosystems. Projects such as WIO- LaB, RECOMAP, and ASCLME have provided support for tracking and monitoring of the fishery resources of the country including monitoring of land-based pollution in coastal waters. As part of the fisheries agreements signed with the Union of Comoros and the EU, the fisheries sector has been the subject of support programs. However, the capacity of Comoros for monitoring, control and surveillance of fishing in offshore waters within its EEZ are very limited.

## 7. References

- Air Transport Statistics, Moroni, 2001-2006. Civil Aviation and Meteorology Directorate General (CAMDG)
- Banque Centrale : Rapport (2007)
- Banque Centrale, Rapport (2008)
- Bayon R. (1999). An Environmental Fund for the Comoros: Issues and Options, Report of Feasibility Study Conducted in Grande Comore and Moheli, Nov. 7-16,
- Ben Oussen (Mohamed): The Comorian islands' struggle against French colonialism (1800-1918), Master's Thesis, Moscow, 1986 (translated from Russian)
- Bigot L (2003). Atlas de vulnérabilité des ressources coralliennes peu profondes, nord et sud de la Grande Comore, ARVAM, AIDE, CNDRS, 52 p.
- BDPA-SCETAGRI, Stratégie agricole, tome 5, (1991)- Ministère de l'agriculture, de la Pêche et de l'environnement
- Chanudet (C): Contribution to the study of Mohéli's settlement. PhD thesis, 3<sup>rd</sup> cycle, INALCO, African studies, Paris... Project Working papers from CNDRS, Comoros, p. 676
- Chanudet (C): A major site of Mohéli: Mwali Mdjini. *Indian Ocean studies* 12:9-123.
- Commissariat Général au Plan (2000): enquête à Indicateurs Multiples –MICS,
- Commissariat Général au Plan (2009): Cadrage macro économique du DSCR final
- Commissariat Général au Plan (2007): Indicateurs socio économiques et démographiques
- Commissariat Général au Plan : Enquête Intégrale auprès des ménages, 2004,
- Comorian Education Literacy, 2003 PRGSP data analysis, General planning commission, September 2005.
- Complete Household Survey (CHS), General planning commission, 2004.
- CBD (2000). Stratégie nationale et plan d'action pour la conservation de la diversité biologique
- COI (2007). Rapport Diagnostic de la situation du Parc Marin de Mohéli (PMM) et propositions d'actions par Jurg Brand, Diagnostic de l'état de l'environnement aux Comores projet
- PNUD/UNESCO/UICN coi/91/006»appui a la programmation nationale en matière d'environnement», novembre 1993 Ministère de l'Environnement
- COSEP (2007) Plan National de Préparation et de Réponse à l'urgence
- Document Cadre Stratégie Touristique, « Les Comores, une destination en devenir touristique» Conférence des Bailleurs de fonds en faveur des Comores, Ile Maurice, le 8 Décembre 2005
- East African Coastal Resources Atlas (Federal Islamic Republic of the Comoros). UNEP, 2002, p. 154
- FAO (2000). Produits forestiers non ligneux aux Comores.
- FAO (2007). Comoros: key agricultural commodity products
- FIDA (2007). Valoriser les potentialités économiques de la diaspora comorienne pour le développement de l'archipel
- Herbert J. C.: An archaeological discovery on Anjouan: the sacred pool of Old Sima, typewritten, 20 p., unpublished
- Herbert J. C.: Agricultural holidays of Anjouan (Comores archipelago), *Society of Africanists Journal*, 30, 1, Paris, 1960, pp. 101-116.
- General Population and Housing Census (RGPH 1991), General planning commission
- General Population and Housing Census (RGPH 2003), General planning commission
- Global report on human development 2008, UNDP 2008.
- Louette M. Meirte M.D. Jocqué R (2004). La faune terrestre de l'archipel des Comores, *Studies in afro-tropical zoology*
- Ministère de l'Environnement, PNUD Loi-cadre N°94-018 relative à l'environnement,
- Ministère de l'Environnement (2006). Programme d'Action National d'Adaptation aux changements climatiques (PANA)

- Ministère de l'Environnement (2002). Résumé exécutif, Communication Nationale Initiale
- Ministère de l'Environnement (2002). Communication Nationale Initiale des Comores,
- Ministère de la production et de l'environnement, non daté, Profil environnemental de l'Union des Comores, Rapport sur le suivi et l'application de la stratégie de Maurice, Novembre 2009, Commissariat Général au Plan
- Ministère de la Production et de l'Environnement (1995). Plan d'Action Environnemental de la République Fédérale Islamique des Comores, Ministère de la Production et de l'Environnement 1995
- Ministère de la Production et de l'Environnement, (2001). Plan d'action environnementale des Comores, Bilan et Perspectives, Ministère de la Production et de l'environnement, Octobre 2001
- Multiple Indicator Cluster Survey (MICS) 2000, Planning Directorate General, 2001.
- National report on human development, Comoros Union, UNDP, 2006.
- PNUD (2008). Document de Projet de Développement des Capacités en Gestion Durable des Terres,
- PNUD (2003). Rapport national sur le développement humain : insécurité alimentaire et vulnérabilité
- PNUD GEF (2000). Stratégie nationale et plan d'action pour la conservation de la diversité biologique document préparé dans le cadre du projet PNUD/FEM/COI/97/GEF 31/ Moroni, décembre 2000
- PNUD GEF COI (2003). (Comores – juillet 2003), Projet Conservation de la Biodiversité et développement durable aux Comores PNUD/GEF COI/97/G32/A1/1G/99
- PNUD/COSEP (2010a). Rapport « Evaluation des mangroves » Restaurer les sites dégradés : un investissement sans regret pour limiter les risques de catastrophes (Parc Marin de Mohéli, Bimbini et Orouveni) Année 2010 Réalisé par : Fouad Abdou Rabi, Consultant
- PNUD/COSEP (2010b) Rapport « Evaluation des récifs coralliens » Restaurer les sites dégradés : un investissement sans regret pour limiter les risques de catastrophes (Parc Marin de Mohéli, Bimbini et Mitsamiouli) Réalisé par Fouad ABDYOU RABI, Consultant
- PNUE/FAO/PAP (1998). L'île de Grande Comore: Profil côtier et stratégie de planification.
- Poverty Reduction and Growth Strategy Paper (PRGSP): Interim Document 2003, General planning commission
- PREDIVAC (2007). Projet de renforcement et de diversification des filières agricoles aux Comores – Présentation sur la qualité des produits agricoles : un enjeu nouveau et crucial pour le développement des exportations de produits agricoles comoriens.
- PROGECO (2008). Evaluation de l'érosion côtière et formulation de quelques propositions en vue d'interventions coordonnées, avec le financement du ProGeCo - Shaveen PERSAND
- Programme d'aménagement du parc marin de Mohéli
- RECOMAP (2007). Coastal mariculture assessment mission, final report prepared by Dr Tom Shipton and Professor Tom Hecht.
- Reyniers F., Sibelet N., Torquebiau E (2002). In : Farming and rural systems research and extension : local identities and globalisation. Pre-proceedings. S.l. : s.n., p. 129-138. IFSA European Symposium on Farming and Rural Systems Research and Extension. 5, 2002-04-08/2002-04-11, Florence, Italie
- UNDAF (2008). Plan cadre des nations unies pour l'aide au développement (UNDAF) 2008-2012, Système des Nations Unies en Union des Comores
- UNDP Climate Change Country Profiles Comoros, C. McSweeney, M. New and G. Lizcano, School of Geography and Environment, University of Oxford, Tyndall Centre for Climate Change Research, <http://country-profiles.geog.ox.ac.uk>
- Verin (Pierre): Anjouan Antiquities, Malagasy Academy Bulletin, XLX, Tananarive, 1967, pp. 69-79.
- Viallard (P.): Grande Comoro Antiquities, Taloha, 4, Tananarive, 1971, pp. 169-184.