



Tsunami Mitigation

Nature Conservation pays off

Rolph Payet (*University of Seychelles*)

Alain de Comarmond (*Ministry of Environment & Natural Resources, Seychelles*)

Contents

1. Country introduction
2. Forests
3. Characteristics of coastal vegetation
4. Role of coastal vegetation against hazards: tsunamis and cyclones
5. Management of coastal vegetation
6. Challenges
7. Conclusions
8. References, PDF Reports and Websites

Summary

The Republic of the Seychelles pays particular attention to maintaining its vegetation on the mountains slopes, the terrestrial coastal plain and in the coastal areas offshore.

Protecting the vegetation helps protect the population against hazards and reduces the impacts of tsunamis and climate change. The coastal vegetation belt absorbed the waves associated with the major 2004 Tsunami, provided shelter for the people living close to the shore and prevented large scale flooding and erosion.

At the same time, the valuable natural resources provide the basis for attracting tourists who make a considerable contribution to the national income.

An holistic vision for sustainable exploitation of the coastal resources is in place, based on legislation and cooperation.

Preparing for future global changes is a challenge for the island community as a whole and international cooperation is actively pursued. The recent creation of the international Sea Level Rise Foundation by the President of the Republic of the Seychelles is an example of the high-level awareness and commitment to preparing adaptive strategies in the face of future global change.

1. Country introduction

The Republic of Seychelles is an island country, consisting of 115 oceanic islands in the western part of the Indian Ocean, some hundreds of miles north east of Madagascar. The Seychelles has a total land area of 455 km² and a total sea area of 1.37 million km². Forty-one of the islands are granitic and they are located within a radius of 50 km from the main granitic island, Mahé. The granitic mountains are densely forested and range up to 900 m elevation. The remaining 74 islands are very low-lying coral islands.

The country has a rich and varied series of habitats, which include a number of endemic species, which deserve conservation and protection.

The Seychelles islands form part of the Indian Ocean Biodiversity Hot Spot and Centre of Plant Diversity (CEPF, 2001). Maintaining the biodiversity of the islands is therefore of utmost importance, particularly in terms of plants, invertebrates, amphibians, reptiles and fresh water fish. The Seychelles has a coral reef area of 1,690 km² with 310 coral species, including eight sea grass species, and 29 km² of mangrove forests with seven mangrove species. The islands form a critical stepping-stone in the bio-geographic distribution and recruitment of shallow marine species across the Indian Ocean.



Figure 1: **The Seychelles, the archipelago** in the western part of the Indian Ocean on its submarine plateau and the main, granitic Island Mahé (total length of 30 km) with the capital Victoria, mountains up to 900 m elevation and large scale land reclamation in the sea. The international airport is constructed on the south eastern land reclamation area.

Mahé, the main island (source: Google Maps: ©2011 Google)

(source:photo: Google Earth: Data SIO, NOAA, U.S.Navy, NGA, GEBCO,

©2011 Europa Technologies, U.S. Dept. of State Geographer, ©2011 Google)



In 2009, 87,500 people inhabited the Republic of the Seychelles, of which 88% live on the granitic main island of Mahé and 10% live on the granite islands of Praslin and La Digue. The 74 low-lying coralline islands support a population of only a few hundred people (FOSA 2001).

The economic development is concentrated on the narrow coastal plain of the three granitic islands. The main economic sectors operating in the coastal areas are agriculture, fisheries and tourism. The tourist sector employs about 30% of the labour force and provides more than 70% of hard currency earnings. The total GDP in 2006 was \$593 million and GDP per capita about \$7,000 (constant 2000 US\$, WRI).

2. Forests

The forest area cover (including coastal vegetation) is estimated at 90% of the land area of Seychelles. About 90% of the forests are natural, while plantation forests cover the other 10%. These forests protect biodiversity, act as water catchments and are under great pressure from various development sectors. The vegetation on many granitic islands consists of lowland forests (0 - 300 m above sea level), intermediate forests (300 - 550 m above sea level), and mountain moss (above 550 m). The slopes of the mountains are covered with forest, which functions as protection against severe soil erosion during torrential rains.

The pressure is highest on the coastal plain consisting of valuable coastal ecosystems such as lowland woodland, dunes, beaches and lowland wetlands including mangroves and in the sea: sea grass and coral ecosystems (see Figure 2). The coastal plains of the three main populated islands of Mahé, Praslin and La Digue are covered by coconut plantations, trees of agro-forestry value and native coastal vegetation.

3. Characteristics of coastal vegetation

The Seychelles has characteristic and distinct vegetation zones typically associated with small island states. The zones are in a natural equilibrium. For example forestry operations in the mountains, affecting the lower lying areas, is strictly limited by regulations effectively enforced by the Ministry of Environment and Transport. The population at large supports this

enforcement, which is well aware of the high value of the vegetation in the mountains and coastal plains.

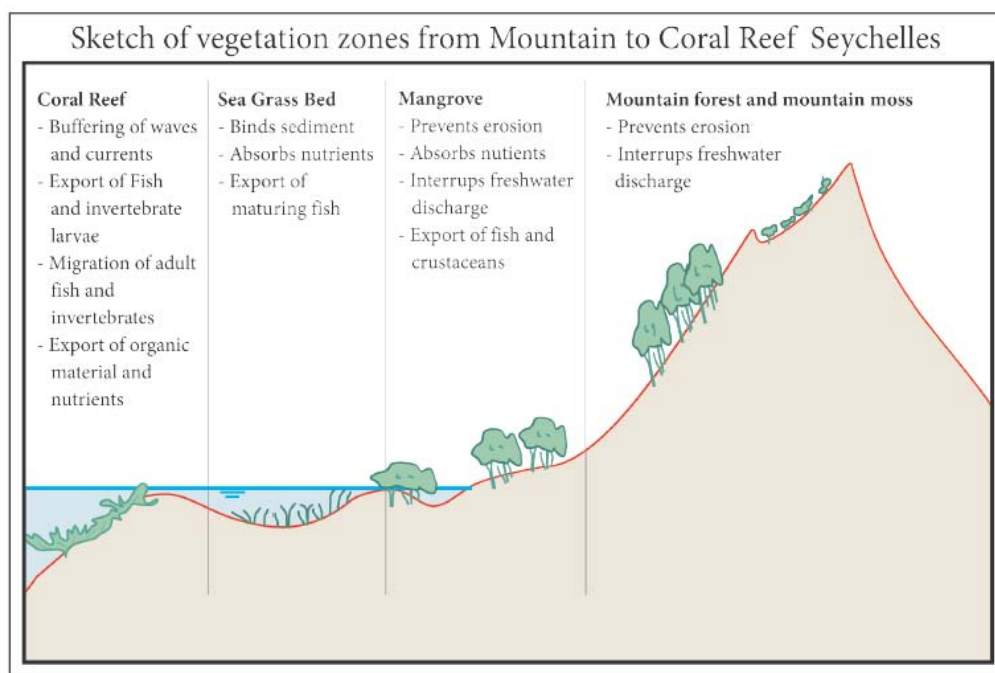


Figure 2: Sketch of vegetation zones from Mountain to Coral Reef.
(source: R.Misdorp)

Littoral zones

The coastline of the Seychelles includes a combination of sandy shores (beaches and sandy flats) and muddy shores derived from fluvial deposits from the islands' rivers. The coastal vegetation of the Seychelles is varied. The most typical beach-fringed vegetation consists of takamaka, coconut trees, casuarinas, patatran, and vouloutier. These vary in their characteristics. Usually there is a clear distinct zonation: creepers on the upper crest of the beach followed by scrubby vegetation and hard wood species on the back beaches. The rocky shores are characterised by granitic headlands and embayments, dropping directly into the sea.

This zonation is not always present. Where shrubby vegetation is absent, the back-beaches and the buffer of coconut trees, takamaka trees and casuarinas, are more exposed to wave action.



*Figure 3: **Cousine Island**, just West of Praslin Island, with creepers and scrubby vegetation on the beaches. (photo: Alain de Comarmond)*

Mangrove forests

Mangrove forests also form a major component of the Seychelles coastline; there are 7 different species of mangroves present in the Seychelles. Mangroves act as a barrier between the sea and the land. Soil washed down by the rivers is trapped in the mangroves and helps protect the coral reefs from siltation. Mangroves also protect the edges of the land from erosion by reducing wave action. They are a habitat for many species of fauna and form important spawning areas for many of the popular reef fishes of the Seychelles. Mangroves are also habitats for many invertebrates in the Seychelles.



*Figure 4: **Mangrove forest on Silhouette Island**, 15 miles NW of Mahe Island, Seychelles. (photo: Courtesy of Ministry of Environment)*

Unlike many other countries mangroves in the Seychelles are not exploited for firewood and timber or used in other direct ways. At some locations mangrove forests are used as express or access-ways by fishermen. One of the major problems of the mangroves is littering. Traditionally wetlands are viewed as ‘smelly wastelands’. Small illegal reclamations by private landowners and developers still occur occasionally and are dealt with under the Environment Protection Act 1994.

All mangroves in the Seychelles are protected under this Act 1994. There is a National Wetlands Policy, which highlights the importance of the ecosystem and grades the different wetland areas into categories depending on their biodiversity. Seychelles is a party to the Ramsar Convention and has already declared one of the largest mangrove areas in the Seychelles at Port Launay and Base Ternay, in the western part of Mahe Island (see Figure 1) a designated Ramsar site.

4. Role of coastal vegetation against hazards: tsunamis and cyclones

The 26 December 2004 tsunami hit the east coast of Mahe and Praslin at midday, an extreme low tide was immediately followed by 2.5 – 3 – 3.5 metres high waves. Refracted waves also hit the west coasts, half to one hour later. A second, somewhat smaller wave hit the coasts four hours later. The sea water surges caused local flooding. Two people were killed and the infrastructure damage estimated at 30 million US \$ (UNEP, 2005b). The damage to the natural resources (UNEP, 2005c) needing short and long term interventions which were estimated at 4 respectively 35 million US \$.

The tsunami was followed by extreme rainfall (250 mm) in the northern and central areas of Mahe, causing severe landslides, tree and rock falls. This caused associated damage to houses, infrastructure and vegetation on the steep slopes.

The coastal vegetation in the Seychelles plays a vital role in protecting the coastline and infrastructures against coastal

hazards such as storm surges, tsunamis and sea level rise.

Such vegetation acts as a natural barrier against all those forces. The typical Seychelles coastal vegetation holds the beach system together providing natural resilience, absorbing and dissipating the energy exerted on the coastline or beach. The tsunami highlighted the importance of this protective function. The sheer force of the Tsunami waves, however, destroyed in several locations the most seaward vegetation (see Figures 5 and 6), causing beach erosion and associated uprooting of palm trees. The more landward vegetation was able to withstand the enormous waves more easily.



Figure 5: **Crushed coastal vouloutier** (*Scaveola cerecea*), hours after tsunami struck Anse Royale beach with waves of about 3 meters height. (photo: A. De Comarmond, 26 December 2004)

It became clear that the impacts of the waves were more obvious and the extent of the damage inland was greater in the few areas, which lacked coastal vegetation.

Thus protecting mangrove systems and coastal vegetation in turn helps protects the inhabitants from severe storm surges and tsunamis. This vegetation with its natural beauty and high biodiversity also supports for a large part the Gross National Product by attracting tourists.

Environmental conservation from the mountains to the reef remains the basis for the present and future economic sustainability of the Seychelles.



Figure 6: Up to 1.5 m cliff erosion of back beaches at Anse Kerlan, north east Praslin Island demolished turtle nests and palm trees - six weeks after tsunami struck the coast. (photos: Robbert Misdorp and Mindert de Vries, February 2005, UNEP Mission: Tsunami Rapid Environmental Damage Assessment)

5. Management of coastal vegetation

For all developments and at all scales, the protection of coastal vegetation is of high priority. The management of the vegetation is covered by several managerial instruments, policies, regulatory measures, legislatures and management programmes.

The Department of Environment is the responsible agency in the Seychelles for the management of coastal vegetation through its day-to-day activities. The Department has a very strict policy against any activity, which adversely affects all coastal vegetation. It is prohibited to uproot, cut, trip or lop any tree or brushwood without permission from the Department. Strong enforcement is at place when needed.

The Department of Environment's National Parks and Forestry Section and the Coastal Zone Management Unit has an annual coastal planting programme. Annually about 50,000 coastal plants are prepared in nurseries and then planted at relevant beaches and shoreline on a regular basis. The planting activities are carried out by the Departmental staff themselves and by the private sector, NGOs, school children and local communities in general. It must be noted that coastal planting is one of the most popular environmental activities undertaken.

The management of coastal vegetation is scrutinised in the Environmental Impact Assessment (EIA) process for all projects and developments. Setback distances are recommended so as to minimise the impact of construction on existing coastal vegetation. The maximum 25-30 m setback line is not regulated under any legislation or by any written policy, however it is one of the most important, if informal instruments used by the Planning Authority and Department of Environment to control the location of coastal development along the coastline of Seychelles.

In order to complement the values of the existing vegetation developers are always encouraged to plant more to increase the protective beachfront in front of their property.

Special measures are also taken, in order to minimise human impacts on the coastal vegetation. The newly planted seedlings for example, are protected from trampling or being crushed by vehicles at beaches, by the installation of bollards. These restrict the parking areas on the beaches.

6. Challenges

The Government of Seychelles is facing the challenge of finding a balance between economic development and the pressure associated with tourism. Other coastal issues are marine pollution, sewage, coastal degradation and erosion and impacts of climate changes.

The Seychelles are particular vulnerable to storm surges and typhoons. Three impacts of climate change will affect the coastal plains of Seychelles:

- Sea level will rise and increase flooding risk and coastal erosion;
- The cyclone belt is widening and is getting closer to the Seychelles (5 – 10 ° S);
- Sea surface temperature will increase and coral bleaching may be enlarged (UNEP, 2005b).

These impacts will affect the economic sectors the country depends on. The island's sensitivity is further enhanced by the fact that the main granitic islands, which rise up to almost three thousand feet, have steep hill slopes prone to landslides, and a narrow coastal plain.

The Mahe's Port, Airport and new land for settlement are built large scale land reclamation areas, protected by revetments. These newly reclaimed areas with a height of about 4 m above mean sea level although well protected, together with other low-lying shores will become more and more vulnerable to flooding and coastal erosion.

A rise in sea level will affect Seychelles if no adaptive measures are or can be taken (FOSA 2001):

- Inundate the low lying part of the coastal plains, effecting the agricultural areas and displacing wetlands;
- Cause the low-lying coral islands, especially the sand cays to disappear;
- Coral reefs will become more stressed by increasing sea water temperature;
- Threaten the fresh water aquifers;
- Increase salinity of mangrove swamps and raise groundwater level affecting plant growth.

The natural protection provided by the healthy island ecosystems, is very important in combating coastal erosion and flooding now and in the future, given climate change scenarios.

In its efforts to build its capacity in understanding the shoreline changes, the Seychelles Government embarked on its National Beach Monitoring Programme in 2003. With this programme, the Department is in a better position to assess and analyse the changes in shoreline and beaches in the long-term.

7. Conclusions

The Seychelles provide a good example of integrated coastal cooperation in an effective economic and ecologically beneficial way. The cooperation between the Ministries and stakeholders result in effective spatial planning and enforcement to preserve and help the sustainable development of the natural resources. There is a broad public understanding of the natural values that need to be preserved. This includes the awareness on the ability of coastal vegetation to reduce the impacts of hazards, such as were demonstrated during the 2004 tsunami and adapt to future impacts of climate change.

Within this framework, integrated nature conservations is a positive force, which increases coastal resilience. The natural coastal defence provided by coastal vegetation proved to be successful against the 2004 tsunami: saving lives, houses and natural resources.

Valuable ongoing integrated coastal management endeavours will be strengthened. This will involve increasing the training of young professionals, improving the capability to monitor the anticipated impacts of climate change, developing adaptive responses and creating a legal framework as an umbrella for these long term and complex activities. The recent creation of the international Sea Level Rise Foundation by the President of the Republic of the Seychelles is a token of the high-level awareness and commitment to preparing adaptive strategies in the face of future global change.

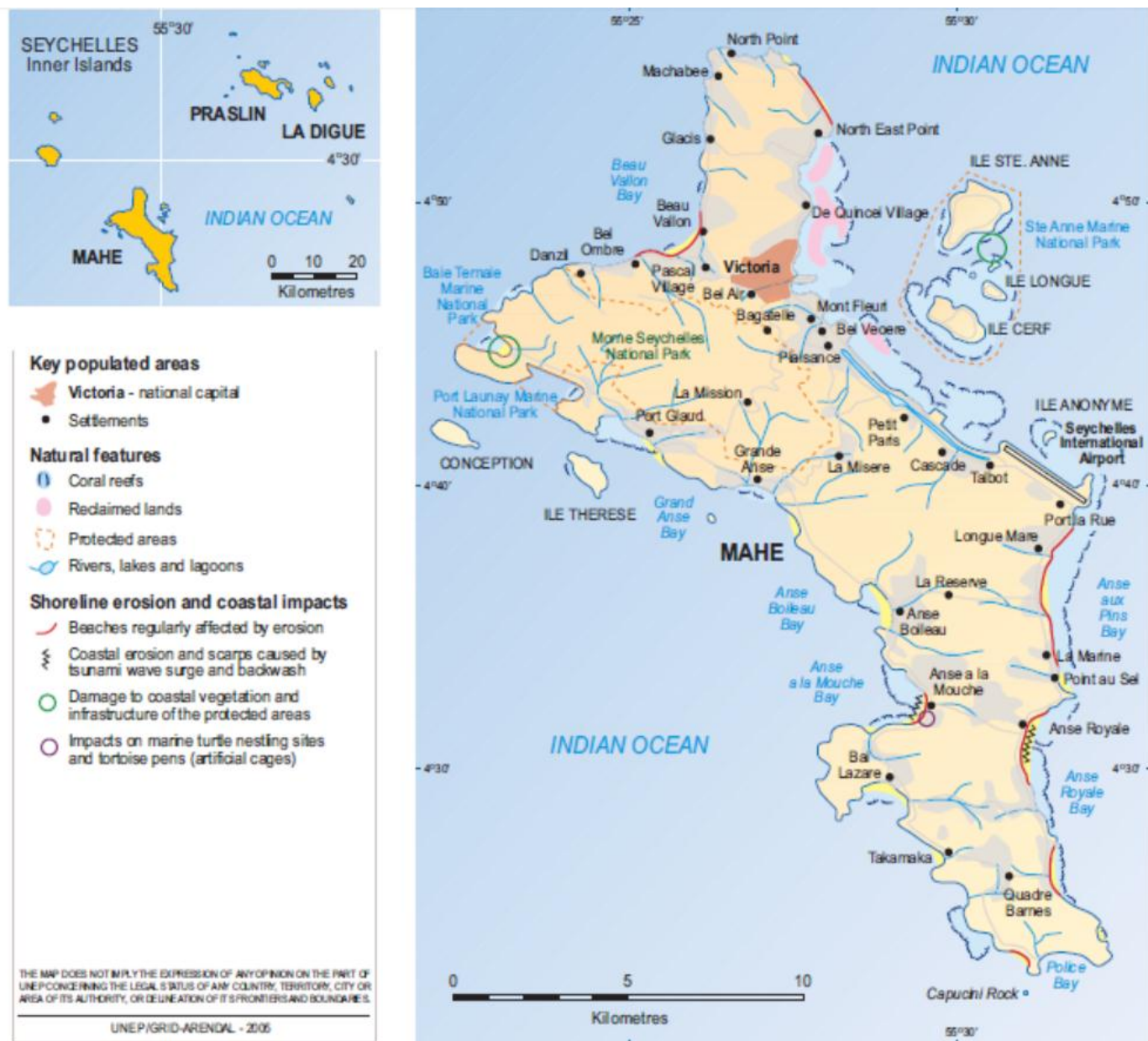


Figure 7: *Natural features, shoreline vulnerability and tsunami impacts - Mahe island, Seychelles.*
(sources: Seychelles' Ministry of Environment 2005, UNEP 2005c)

8. References

FOSA - Forestry Outlook Studies in Africa, 2001 : *Country Report - Seychelles*; FOSA Working Paper – 38, Series title: Forestry Sector Outlook Studies , FOSA/WP/38 2001, 36 p

UNEP – United Nations Environment Programme, 2005a: *Republic of Seychelles: From the mountains to the reefs*; Mission report of the UNEP Asian Tsunami Disaster Task Force, UNEP, Nairobi, p 65, February 2005

Weblinks:

- **International Sea Level Rise Foundation:**
http://www.statehouse.gov.sc/index.php?option=com_content&view=article&id=85&Itemid=75 and <http://sealevelrise.blogspot.com/>
- **WRI: World Resources Institute:**
http://earthtrends.wri.org/searchable_db/index.php?theme=5

PDF Reports:

- **FOSA 2001:**
<ftp://ftp.fao.org/docrep/fao/004/AB594E/AB594E00.pdf>
- **UNEP, 2005b**: *After the Tsunami – Rapid Environmental Assessment, National Rapid Environmental Assessment- Seychelles*; pages 96-112 in ISBN 92-807-2565-3, UNEP, Nairobi, February 2005:
http://www.unep.org/tsunami/reports/Tsunami_SEYCHELLES_LAYOUT.pdf
- **UNEP, 2005c** : *SEYCHELLES: Post-Tsunami Environmental Assessment*; UNEP, Nairobi, November 2005, p 64:
http://postconflict.unep.ch/publications/dmb_seychelles.pdf
- **CEPF – Critical Ecosystem Partnership Fund 2001:**
<http://www.cepf.net/Documents/final.madagascar.ep.pdf>