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IOC Manual and Guide N°62,
ICAM Dossier N°7

A Guide on Adaptation Options for Local Decision-makers

GUIDANCE FOR DECISION MAKING TO COPE WITH COASTAL CHANGES IN WEST AFRICA

Abbreviations

ACCC	Adaptation to Climate and Coastal Change in Western Africa
MPA	Marine Protected Area
CC	Climate Change
IOC-UNESCO	Intergovernmental Oceanographic Commission-UNESCO
GEF	Global Environment Facility
IPCC	Intergovernmental Panel on Climate Change
JICA	Japan International Cooperation Agency for Development
UNDP	United Nations Development Program
UNEP	United Nations Environment Program
DC/PVD	Developing Countries/Pays en Voie de Développement
BR	Biosphere Reserve
SINEPAD	Interim Secretariat of NEPAD (New Partnership for Africa)
AU	African Union
UCAD	Cheikh Anta Diop University of Dakar
IUCN	International Union for Conservation of Nature
UNESCO	United Nations Educational, Scientific and Cultural Organization
WACAF	West and Central Atlantic Africa
WAAME	West African Association for Marine Environment

Credits

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Guide on adaptation options in coastal areas for local decision-makers

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Editorial

The coasts of Africa are threatened with increased human pressures which combined with existing natural phenomena such as erosion, will lead to flooding of low lying areas, the degradation of mangroves and salt intrusion in soils and water. In most coastal states of West Africa, the impact of predicted climate changes will bring new concerns for populations, but also for investors and policymakers. Given the economic importance of these coastal areas, it is now unthinkable to delay action as the cost of inaction will be greater than efforts to adapt now. However, acting in haste, whilst demonstrating willingness to adapt, can generate even greater risk such as "maladaptation" through adverse impacts resulting from bad decisions.

Because **climate change is now a reality**, the phenomena associated with these changes will intensify in the coming years. When one holds a position as decision maker, it is important to bear in mind that in addition to human lives that depend on the choices we make, we also have infrastructure such as ports, fishing and tourism facilities that could disappear and nullify economic development efforts that must be preserved. It is therefore paramount to build on sound and scientific advice to guide actions on coastal adaptation. It is in this vein that we have designed these guidelines to aid decision making, and these are primarily intended for local decision-makers working in the coastal zone.

Through the implementation of the GEF Project on Coastal Adaptation in West Africa (ACCC), we have been able to document a large amount of experiences from coastal managers, scientists, engineers on the implementation of concrete adaptation techniques. You will find **10 fact sheets** summarizing national experts' experiences from The Gambia, Ghana, Mauritania, Nigeria and Senegal, which constitute a true "toolbox", reviewing options of adaptation to climate change in coastal areas. In a few pages, we are presenting options to expand opportunities for stakeholders. We hope the reader will find useful the practical advice ranging from solutions that involve the construction of structures to the implementation of principles for improved management of natural resources, mainly through non-structural options.

This guide is a collective work that provides **local communities** and their policymakers, options, based on cost-effectiveness and human resources available, for the most appropriate techniques and lasting solutions to the impacts of climate change threatening the survival of your communities and the attractiveness of your areas.

We hope that sound decisions will be made, taking into account the impacts generated on populations and ecosystems, as this is the responsibility of decision makers towards **present and future generations.**

We wish you an excellent reading!

Wendy Watson-Wright,
Assistant Director-General of UNESCO,
Executive Secretary of the Intergovernmental Oceanographic Commission of UNESCO

Introduction

Whether we speak about adaptation or about the mitigation of its impacts, climate change is now a reality. Such a collective awareness is a prerequisite to any action because, once the factors and causes of climate change are known, no one can pretend having no response. These solutions are real fighting strategies which, to be effective, must be monitored, maintained and accompanied, especially in developing countries known to be the most vulnerable to climate change impacts. Indeed, climate change will impact natural, economic and human systems which, because they are complex and differ from one region to another, shall cover both water resources and land management or populations.

It is important to remember that sea level rise is one of the major challenges induced by climate change. "*The Blue Economy" – derived from the oceans - plays a central role in our daily lives. The seafood is the main source of protein for at least one in four persons. Half the world population lives in coastal areas within 50 kilometres range from the sea. Ninety percent of the world trade is done by sea. Thanks to technological advances, economic activities in coastal areas and in deep water are increasingly intensifying and diversifying*"[1]. However many are those who ignore the size of these impacts, not only on natural equilibrium, but also on the economic and social life of people.

We therefore undertook to contribute to one of the strategies against the manifestations of climate change by producing this information on adaptation options in coastal areas. This information and the experience sharing are crucial in this area because the victims of climate change can learn from their respective experiences. Once shared, these experiences will help other vulnerable groups under the same conditions to identify ways of action and avoid the inappropriate use of improvised strategies and options. After a review of erosion problems, this guide presents the key concepts for understanding the phenomenon of coastal erosion and the different types of defence, but also management of resources, their characteristics and costs in 10 fact sheets.

The purpose of this guide is to provide local decision-makers with the options categorized as follows:

- Three **hard engineering** options for the construction of more or less rigid defence structures (seawalls, groins and revetments);
- Three **softer non-structural** options in harmony with coastal dynamics (artificial nourishment of beaches, dune replenishment, and mangrove restoration);
- Four options for **integrated management of ecosystems** (land management, management of water resources, sustainable community management of fisheries resources, and marine protected areas).

1 Excerpt from the address of Mrs. Irina Bokova, Director General of UNESCO, at the World Oceans Day. Source : http://unesdoc.unesco.org/images/0019/001927/192759f.pdf

By presenting different techniques to adapt to the climate change identified in the African coastal zone on its Atlantic side, this guide aims to expand the intervention possibilities of stakeholders who, as they are too often torn between the many priorities they face, are making decisions in a hurry at the risk of opting for a solution the implementation of which can be a source of dire consequences for the future of the community. The guide also opens a perspective for the inclusion of environmental management as a whole, the coastal erosion issues being generally part of a set of environmental challenges that local decision-makers have to manage. Whether for building a seawall, creating a marine protected area or observing a period of "biological rest", the guide on adaptation options in coastal areas includes practical experiences in the implementation of structure and non-structure options, and integrated management of natural resources, providing local decision-makers with relevant information.

A final concluding chapter describes the requirements for monitoring and evaluating the implementation of these 10 options. It also offers a comparative analysis of their positive and negative impacts to assist in decision-making. Thanks to the operational advice presented, local decision-makers will determine the relevance and, depending on the context, adopt one technique rather than another, based on objective criteria.

REVIEW OF KEY CONCEPTS

What do we know with certainty about climate change?

When it comes to coastal erosion, climate and coastal change and its effects on the coast of West Africa, it is essential to ensure that stakeholders have accurate and high quality information. Recent observations have shown that we are already well beyond the projected maximum elevation of sea level made for the period 1990 - 2100 and that despite the urgency to act, decision-makers will not all be able to calculate the "recession rate" of beaches. Another expected consequence of the global warming is a strengthening of westerly winds, coming from higher latitudes, which are already evident in some places, especially with stronger waves affecting the coast and increasing coastal erosion. It is equally relevant to ensure that the stakeholders, for whom this publication is meant, have sufficient understanding of the key concepts contained in this guide. This section presents the key terms used so that all readers can easily become familiar with this topic.

What is coastal erosion?

It is already a reality in many countries worldwide, as over 70% of sandy coasts are now eroding. Resulting from a combination of both natural and human factors taking place on multiple temporal and spatial scales, coastal erosion occurs when the sea is gaining ground on the earth through the action of wind, movements of waves and tides and when sediment (sand) becomes insufficient to provide natural protection to beaches. While this erosion is a natural process that has always existed and shaped the shores of the world, it is nowadays clear that its scope is far from being only natural. Many human factors contribute to exacerbate this phenomenon including:

- Beach sand extraction because of the high demand for building materials for human settlements;
- The construction of structures perpendicular to the coast;
- Constructions near the coast or on the beaches;
- Deforestation of coastal dunes and mangroves that play a stabilizing role against coastal erosion.

These processes are followed by land salinization phenomena that pose problems both for farming and drinking water supplies for people and animals. Traditional activities (such as rice farming) are abandoned in favour of the exploitation of salt, as is the case for example in Palmarin (Senegal). Polarization of populations along the coastal zone in urban areas should also be noted. In Mauritania, for example, the nomadic population has gone down from over 70% in 1960 to less than 10% currently[2] is now established on the coast line.

What is the variation of the shoreline?

This term refers to the recession of the waterfront as a result of coastal erosion. The shoreline is the meeting point between the sea and land: the higher the elevation of sea level, the greater the horizontal recession will also be. For example, 50cm of vertical rise in sea level can produce up to 50 meters of horizontal recession of the shoreline. With the backward movement of the shoreline between 1 and 2 m per year on average - which can sometimes be even higher under certain circumstances - some coastal states are in fact seriously threatened in West Africa:

2 Source : www.erosioncotiere.com/index.php?option=com_content&task=view&id=10&Itemid=7

In Mauritania

The most exposed area is the city of Nouakchott, especially at the port built in 1986, where protective structures in place (a check dam built in 1987, then a protection groin in 1991) tend to collapse. Recession rates of 25 m per year have been registered in this area. According to information disclosed during the caravan of the Mauritanian coast (Association of Parliamentarians), it is confirmed that the village of Ndiago (community near St. Louis, Senegal) is also threatened;

In Senegal

Large coastal cities to the south along the "Petite Côte" and north (near St. Louis) are almost all concerned with the encroachment of the sea, which constitutes a serious threat to the prestigious tourist facilities they provide. For these areas, the rates of recession vary substantially between 1 and 2 m per year. Rates up to 137 m per year were recorded in the case of the breach in the Sangomar offshore bar. It is important to note that this type of erosion pace, extremely fast, will persist as long as the situation has not further stabilized;

In The Gambia

Coastal erosion has justified the development of infrastructure for consistent protection of the coast. Despite this, the Gambian coast remains a concern, particularly in the area of Banjul. Recession rates of 1.8 m per year are registered for the section of coast between Cape Point and Bald Cape. Also, many tourist facilities, like those of the Senegambia Hotel are still under threat, while others have completely disappeared, like some hotels close to Banjul, the capital;

In Guinea Bissau

The Varela beach for example is subjected to a severe process of erosion reported to be at least 2 m per year. Other parts of the country are affected as is the case of Bubaque Island and the islands of Porcos and Melo, located in the Bijagos archipelago;

In Cape Verde

Although it is likely that coastal erosion affects a number of islands, the lack of official statistics on the magnitude of the erosion impedes any certainty. However, in selected areas under the ACCC project, some values higher than 2 m per year of shoreline recession rate were reported.

Why is it necessary to adapt?

Given the economic importance of coastal areas - characterized by a high concentration of populations, port, fisheries and/or tourism infrastructure - we must also underscore the importance of preserving vital ecosystems for biodiversity, even beyond the profits from key sectors such as fishing and tourism that also depend on environmental conditions. It is not sufficiently emphasized that coastal areas, on the one hand subject to degradation of natural origin, suffer on the other hand extreme pressure from residents. By polluting, plundering and devastating their environment, people aggravate the erosion and degradation of natural areas at risk. But, in order to act effectively against the negative impacts of climate change, while benefiting from the opportunities it offers, local communities living on the coast must now have full control of the situation in order to select and apply appropriate measures in terms of adaptation.

What impacts should we adapt to in coastal areas?

One of the most certain consequences of climate change is the rising sea level which, on present trends, will continue to accelerate. Indeed since 1900, tide gauges have recorded a rate between 1 and 2 mm rise in the sea level per year et since 1993, satellite data have shown a marked acceleration of this rate. Climate models (1990 and 2100) predict a steady rise in sea level between 9 and 88 cm depending on the development options to be selected. This implies for example that by 2050, the upper level indicated by the projections would be 5 to 32 cm (compared to 1990), well above the rates of sea level elevation that we know today. These projections are even more disturbing that recent data obtained are already well above the maximum projections. Risks of experiencing a greater rise in sea level are real (UNEP, 2008), hence the importance of ensuring the regularity of follow-up of the sea level.

Table 1: Impacts of 1 m rise in the sea level in five coastal countries of West Africa

	The Gambia	Guinea	Mauritania	Senegal	Sierra Leone
Land at risk (km^2)	92	289-468	874,5	6042-6073	
Population at risk (x 1000)	42	500		109-178	26-1220
Economic value at risk (millions US$ and % of GNP)	217* (52%)		6330 (542%)	499-707 (14%)	2315,860
Adaptation cost (millions US$)	4.4		1824,5	973-2156	
GDP (millions US$)	461 (2007)	3407	1064	4971	

Source: Niang-Diop, I. (2005). Impacts of climate change on the coastal zones of Africa. In: IOC "Coastal zones in sub-Saharan Africa: A scientific review of the priority issues influencing sustainability and vulnerability of coastal communities", London, 27-28 May 2003, Workshop Report 186, ICAM Dossier n°4, 27-33.

The impacts of the rising sea level in coastal areas are the best known. We know that in terms of biophysical impacts, the currently observed phenomena, including coastal erosion, will accelerate. This will generate a number of socio-economic impacts that, for now, are recorded in terms of population to relocate, investments lost or threatened economic activities to be modified or moved. These economic values at risk must be determined to apply appropriate solutions. The values shown in the table below (Table 1) must be regarded as minima because only some elements available were considered (value of land and buildings sometimes).

It turns out that the costs of impacts thus calculated are already from 10% to 50% of the Gross National Product (GNP) as shown in the above table compiled from data from the initial national communications at the UNFCCC from 5 West Africa countries. However, the adaptation costs are usually lower than those of the economic values exposed to climate risks. In any case, they must be studied in-depth.

Why is the role of local decision makers essential?

While negotiations are underway on the international level, adaptation to climate change shall first be undertaken locally. Various officials at this level must be fully aware of their responsibilities, which include:

- The need for sound management of natural resources taking into consideration the possible effects of climate change. This means the implementation of local development plans, and land occupancy plans enabling adaptation to climate change (maintaining availability of land located high up, good management of water resources, protection of habitats and important species for fish farming and tourism);

- The need to master advanced knowledge of adaptation options;

- The need to develop awareness and inform people so they can understand the phenomena in progress and better implement local policies (protection, better management, land use, etc.).

- The need to establish a monitoring policy (M&E) involving directly affected communities: the issue of structures involves greater reactivity, particularly through the establishment of a monitoring and warning system so that solutions are implemented. This is discussed in the last chapter.

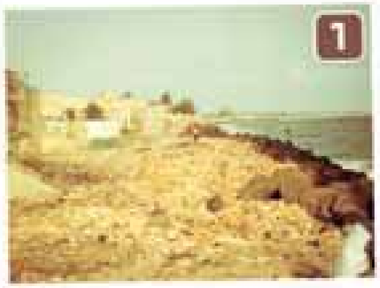
Fact sheet 1

Seawalls

Author: Isabelle NIANG

Seawalls are gravity-base structures placed between the backshores and the infrastructure located immediately behind. They are erected parallel to the coast, with the main function of protecting the facilities located at the back against the risk of flooding by sea water. These are structures meant to minimize the damage caused by very heavy swells. They do not protect the beaches at the ends of the walls and do not fight against the causes of erosion.

OPTION	IMPLEMENTATION
Seawalls	These structures are simple to make but require the intervention of a construction company that will be responsible for transporting the materials and arranging them according to the plan adopted for its construction. Such structures can be built with different materials (wood, rocks, concrete, etc.). In all cases, seawalls are only designed to protect the land and infrastructure located on the backside. Their function is neither to protect adjoining beaches, nor to those located between the sea and the wall. Most often, the former is subject to increased erosion while the latter would disappear. Wherever possible, the walls must be extended by connecting arms at each end to prevent the phenomena of skirting round by waves. To mitigate the negative impacts of the walls, you can take advantage of their slope (the flatter the angle, the less problem you have) and permeability (when it is irregular, as is the case with riprap, there is more dissipation of the wave energy which is no longer available for reflection). These are costly structures (see section on costs below) which require maintenance to extend their lifespan. Besides, seawalls seem to lead to the disappearance of beaches located in front, due to phenomena of reflection of waves.



PRACTICAL EXAMPLES

The case of Rufisque in Senegal

Two types of seawalls were used

The riprap walls of Keuri Kad and Keuri Souf 1

These structures built according to a concept proposed by a group of Dutch consultants are trapezoidal dikes 5m wide at the top and 12 m at the base. Their peak is located at 5m+ above sea level. The slopes are 45° and the structure is based on a geotextile filter. The body of the structure consists of rubble limestone of 3 to 5 kg and is protected on the seaward side by basalt blocks of 1 to 2 tons. These walls were built between 1983 and 1990 and are 3.5 kilometres long in total, with 2.85 km between Keuri Souf and Bata. A recent evaluation has shown that these walls collapsed in places. These structures are so fragile, poorly protected and cannot prevent the highest waves from overtopping. Moreover, the absence of connecting arm at the southern end of the wall explains why waves are skirting round and the Muslim cemetery of Thiawlène is highly exposed.

The concrete walls of Diokoul 2 3

Designed by the Public Works Department, they were built between 1990 and 1992 at Diokoul. These are concrete walls resting on rock-filled gabions. These walls are currently in failover or collapse situations. A new vertical concrete wall was built before the first wall collapsed.

Some other cases

The seawall of Keta in Ghana 4

To control erosion, a seawall of steel sheet piling was built in 1955-1956; its construction was stopped in 1960 due to continuing coastal erosion. The structure quickly collapsed soon after.

The cost of this technique

The estimation of these costs must include:

- The availability of materials, depending on the desired shape of the seawall;
- Materials transportation costs
- The machinery (cranes, tippers, trucks) needed for the construction of the wall.

According to the vulnerability study of the Senegalese coast, costs were estimated at

- Between 4.6 and 5.33 million US $ per km of seawall (1US $ = 600 FCFA). These structures are therefore expensive options which also need to be maintained in order to extend their lifespan.

Fact sheet 2

The groins

Author: George NAI

The groins are cross-stream structures, constructed and installed to control the movement of beach sand, leading to the trapping and accumulation of sand between these structures. Arranged perpendicular to the shoreline, they can serve as a single structure to meet a particular need, but in most cases they are built in series to form groin fields. The groins can lead to complex patterns of currents and waves, hence the importance of monitoring.

OPTION	IMPLEMENTATION AND IMPACTS OBTAINED DEPENDING ON MATERIALS
Groins	The groins option is generally chosen along beaches where the movement - mainly sediment movement through the currents – parallel to the beach is quite significant at any time of the year to ensure proper operation of the groins depending on the desired goals and objectives. Groins reduce parallel movement to the coast by trapping beach materials and lead to a change in the direction of the beach relative to the directions of the dominant waves. These structures mainly affect the transport done by overthrusting - a mode of transport from the bottom - and are particularly effective on gravel or pebble beaches. The sand, when it is transported temporarily in suspension during periods of high wave or current energy, will tend to be carried over or around any structure perpendicular to the shore. Several types of materials can be used and produce different impacts. • **Rock groins** have the advantage of being based on simple construction methods. They are sustainable on the long-term and have the possibility to absorb the wave energy due to their semi-permeable nature. • **Wooden groins** last for a shorter period of time and tend to reflect the energy rather than absorbing it.

OPTION	IMPLEMENTATION AND IMPACTS OBTAINED DEPENDING ON MATERIALS
Groins (more)	• **The tar or rock-filled gabion groins** can be useful measures for temporary or short term erosion control, but applications made recently in West Africa, particularly in Ghana, have shown that they can also be used as medium and long term measures for coastal stabilization. In the case of beaches with a predominant wave direction, the groins should be oriented perpendicular to the crests of breaking waves. A groin field must end with terminal groins to prevent downdrift erosion. If sediment transport processes are mostly perpendicular, we must therefore choose breakwater systems instead of groins. The construction of groins should normally be accompanied by a recycling or artificial beach nourishment program. To succeed, this technique should include a mechanism for regular monitoring and management. Monitoring should include close shorelines as well as those located within the groin field. Heights, lengths and profiles of groins can be modified if monitoring can tell that the initial plan will not lead to achieving the objectives. During maintenance operations, we must rectify any damage observed such as movement of rocks. In the case of gabion structures, any damage to the PVC coated baskets should be repaired immediately to avoid loss of rocks from the baskets. The author's personal experience has shown that gabion groins have a higher ability to dissipate energy of waves than rock-filled groins. The construction method in the case of rock-filled gabions is so simple, not to mention that this is a low cost and less complex technology coastal protection technique.

PRACTICAL EXAMPLES

Coastal protection in Keta (Ghana) with the construction of 7 riprap groins

1

Erosion in the Keta area began between 1870 and 1880 after the sea had removed 200 to 300 m of land near central Keta which is located on the eastern part of the estuary of the Volta River. Since then, various protective measures taken to stabilize the coast did not yield the desired results. A steel wall (made of sheet piles) 1 was built in the years 1955 to 1956 but collapsed in the 1960s. From 1976 to 1978, temporary measures including the use of rocks in revetment to protect the Fort of Keta gave negative results due to the absence of filter material under the lining, as most rocks are sinking into the sandy material. After several years of studies on coastal erosion in Keta, the Government of Ghana has finally accepted the proposal made by *Great Lakes*


2


3


4

Construction Company of the USA to design and build 7 riprap groins to stabilize a coastal stretch of about 7.5 km long, separated by 220m and 250m, which were built between 1998 and 2003 2; The building materials[3] were extracted from the Metsrikas quarry (65 km from the construction site). It was expected to accelerate the rate of accretion of sandy material between the groins by ensuring artificial nourishment of the beach with dredged material. But because of the existence of an adequate supply of material close to the shore, part of the sandy material was trapped naturally and was supplemented by artificial nourishment on a relatively short period of time. Since the project is completed, the coastal stretch has been fully stabilized and secure along 7.5 km, allowing for the implementation of structures, including the creation of social amenities for the communities that were previously highly vulnerable to severe attacks by waves. The communication channel between Keta and Kedzi has been restored on 10 km and the inhabitants threatened by erosion could return to their home communities. The project includes a tidal gate across the road at Kedzi to control high tide levels in the lagoon and high water flows from the Sea 3.

The project is a complete success and has become a reference for future projects of similar nature, such as the Ada defence project located west of the estuary of the Volta, consisting of several groins for protecting the coastline over 20 km.

The success of the project can be attributed to the implementation of best practices in coastal engineering and strict adherence to the specifications in the design and construction. The availability of adequate funds made available by *EXIM Bank of USA* has made the work possible since its early stages until the end of the project. In particular, the adequate provision of good quality quarry materials available at a relatively close distance from the site contributed to the implementation of this project on schedule.

Erosion control Project in Cotonou (Benin) with the construction of 5 gabion groins

The project for erosion control in Cotonou was designed as a prototype study, hoping to replicate it in other parts of West and Central Africa (WACAF region). It involved the construction of five short and low height groins in Cotonou, Benin's capital. The project was conducted jointly by the AU and UNEP, with support from the Government of the Republic of Benin. The objective was to

3 Amour rocks, boulders and chippings.

stabilize the shoreline in front of the new residential area which suffered a marked decline in the coastline at a speed of 2 to 3 m/year 4. During preliminary onsite investigations, it was observed that the construction of the Port of Cotonou had a single long riprap groin (Figure 7) built in 1962 which led to a strong accretion of the shoreline to the west of the port. In 1988, the shoreline had advanced about 650m on the western edge of the Port (current site of Sheraton Hotel) while on the eastern edge of the Port, the coast had receded by about 500m over the same period. This erosion control project, using direct labour has not been completed in accordance with the specifications because of inadequate funding. It was impossible to achieve significant results because of the limited number of groins installed. The materials used consisted of gabions, rock of various size and geotextile filter. As a pilot project, monitoring of the site was required in order to adjust design parameters, and if possible, to make the necessary readjustments; which was not the case. Because of these serious defects, but also the lack of routinely maintenance of partially completed structures, the project was eventually abandoned. Furthermore, because the project site was located downstream of the Port of Cotonou where the long groin (Figures 6 and 7) is located, the new groin field could not benefit from supply of sand transported parallel to the shore. So this project was a total failure. This example illustrates the need for getting all details of the problem and carrying out specific investigations on the site to determine the validity of the technical solution chosen.

The cost of this technique

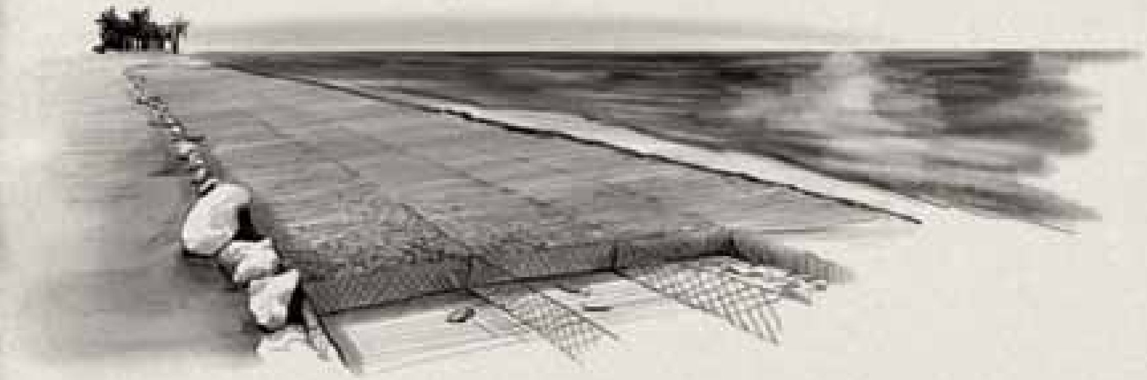
- The project of Keta: **U.S. $ 85.00 million**, representing an average cost of about **U.S. $ 11.300** per linear meter for the groin field, including artificial nourishment, road infrastructure and discharge structures.
  - The unit cost for protecting a shoreline stretch over 13 km resulting from a 7.5 length of groin field is about U.S. $ 6,540 per meter.
  - Monitoring and evaluation are estimated at a cost of U.S. $ 1 million or U.S. $ 75 per linear meter.
- Work at the Port of Cotonou: about U.S. **$ 76.000.**
  - The project was implemented with direct labour made available by the Government of Benin and supervised by a Civil/Coastal Engineer in Ghana.
  - The average unit cost for implementing this project was approximately U.S. $ 250 per linear meter of shoreline.
  - Monitoring and evaluation are estimated at U.S. $ 1000 or U.S. $ 3.50 per meter.

Fact sheet 3

Beach Revetment

Author: George NAI

A beach revetment is a structure installed parallel to the coast consisting in covering the beach with materials more resistant to waves than the beach sand (see Figure 2). The main difference with a seawall is that the slope is flatter. Its surface may be smooth or rough and its dimension is not necessarily equivalent to the distance between the beach and the mainland.



OPTIONS	IMPLEMENTATION
Revetments with rigid or flexible structure	Several types of materials of different conditions can be used to obtain the stabilization of a beach. Revetments are particularly suitable in the case of high and moderate energy environments where severe erosion of the beach already occurred. They have the advantage of being flexible and can be adjusted in case of erosion or subsidence of the bank. They can be perceived as having less value for recreation compared to other structures such as limestone walls. However, a well constructed and well maintained revetment cannot interfere with public use of the beach. We must consider the aesthetic aspect in a case by case basis and generally prefer local stones for making the revetments which may consist of either rigid structures (concrete blocks) or flexible structures (rip-raps, meaning layers of rocks protecting an embankment against the action of water). Rigid structures tend to be more massive, but are generally inappropriate to deal with a structure-based adjustment or compaction of underlying materials. A flexible revetment is made of lighter units that can tolerate varying degrees of movement.

PRACTICAL EXAMPLES

1

2

3

James Town beach revetment in Accra (Ghana) 1 2

A first revetment of 100m long was built between 1959 and 1960; it was part of a package of measures to counteract coastal erosion, which was undertaken during the construction of the spillway of Korle Lagoon. After 15 years, this revetment has been severely attacked by overtopping sea waves. The "run-up" and overtopping also affected the road located east of the revetment, with an interruption of the road between Korle lagoon and central Accra at high tide. The width of the beach adjoining the road was seriously eroded and reduced to 5-7 m wide. To address this situation, a low cost and low technology gabion revetment was proposed and implemented between 1983 and 1984. This revetment was made of PVC coated gabions to provide protection to the most affected part of the road along the beach that stretched for 200 meters. Within 12 to 18 months, the results achieved were remarkable. The overtopping of the road by the swells had ceased; substantial accretion occurred and beach profiles became flatter than before the installation of this revetment. The main factors responsible for this high rate of accretion were the flat slope of the revetment and the effective dissipation properties of the rock-filled gabion structure.

Labadi Beach Revetment (Ghana) 3

Here, the shoreline recession rate was 3 to 5 m per year between 1955 and 1985. The period that recorded the highest recession rate is between 1965 and 1978, when an area of 100 m of beach, considered safe for the development of a leisure project suffered an average erosion rate of 7.5 m per year, which led to an immediate suspension of any development project in the area. The main component of the structure, the construction of which began in 1982, was made of rock-filled gabions. It was the first time the gabion technology was used to solve coastal erosion problems in Ghana. The immediate objective was to provide temporary protection to a cafeteria the foundations of which had been undermined by scouring and were in the process of collapsing. Before that, other low cost and simple technology protection techniques (using a mixture of wood and sandbags) had been tried unsuccessfully. The Labadi shoreline protection project, which involved 1,600 m of beach, was organized around three steps that gradually led to mastering the technique. After a pilot phase, it was decided to reduce the slope of the revetment (by 1/2.5 to 1/5) and to replace, for the base of the structure, riprap gabions by boulders, once at the area of rocky outcrops. After completion of the gabion revetment structure, the beach is now protected from attacks by waves; the bathymetry of the submarine beach has become flatter and a sense of safety was created. This improved situation has led to reviving various components of the Pleasure Beach project, which is part and parcel of La-Palm Royal Beach Hotel complex project completed 15 years ago.

The cost of this technique

Cost of the rock-filled gabion revetment at Jamestown Beach was **U.S. $ 435** per linear meter of protected shoreline.

- Monitoring and evaluation: an estimated cost of U.S. $ 5 per meter.
- Cost of the Labadi Beach revetment project: U.S. $ 1,300 for Phases I and II.
- A total cost of U.S. $ 1,600 for Phase III per linear meter of protected shoreline.
- Unit cost of monitoring and evaluation is estimated at U.S. $ 20 per meter.

Fact sheet 4

The artificial nourishment of beaches

Author: Regina FOLORUNSHO

Artificial nourishment consist in dropping granular sediment loads on a littoral zone by mechanical means such as dredging of offshore deposits with trucks of materials from the mainland. The resulting beach provides some level of protection for the area behind it and is itself a value-added resource, particularly for recreation and tourism. This artificially replenished beach behaves as a buffer zone against erosion. Its lifetime depends on the speed at which it is eroding. Serious and frequent storm surges[4] may completely devastate a beach recently nourished artificially and within a relatively short period of time.

OPTION	IMPLEMENTATION
Artificial nourishment	This is a suitable method to fight against coastal erosion in the case of low-lying areas that are not influenced directly or indirectly by natural headlands, rocky outcrops or other coastal structures. This option is generally used in an emergency situation or as an ad hoc measure of erosion control while seeking a long-term or permanent solution to the problem of coastal recession and flooding. As a high value, soft and environmentally friendly solution to erosion and/or loss of property and loss of land, this technology may be most appropriate for beaches used by tourists. One of the prerequisites for a successful implementation of an artificial beach nourishment plan is the identification and assessment of reliable sources of granular materials, in terms of quantity and quality, in order to ensure an uninterrupted supply of materials during replenishment and nourishment exercises. Based on the experiments described below in The Gambia, the following recommendations must be observed to ensure operational success of artificial beach nourishment. **1)** Conduct a study taking into consideration the nature of the beach, its major functions, the sediment composition and natural forces acting on it. **2)** Assess the response of the beach to extreme events and find out the influence of structures such as breakwaters or others.

4 A storm surge is when the high tide exceeds its normal level or an abnormal recession of low tide, induced by unusual weather conditions

OPTION	IMPLEMENTATION
Artificial nourishment (more)	**3)** Create a beach management unit to regularly assess the various options and techniques that can be implemented to address the problem (s). This should be supported by the following monitoring measures to ensure maintenance of the project: - Production of regular and controlled beach profiles - Verification of the implementation of a minimum "set back" from the mean high tide line for construction - Prohibition of sand mining on the beaches

PRACTICAL EXAMPLES

Bar Beach in Lagos (Nigeria) 1 2

"Bar Beach" of Victoria Island in Lagos (Nigeria) is located east of the eastern pier downdrift (compared to the littoral drift) the natural mouth of the port of Lagos. This beach was the scene of intense erosion (about 20 m/year) in the past and since the construction of the Eastern and Western Piers of the entrance to the port of Lagos, between 1908 and 1912, built to protect the dredged entrance (Commodore Channel) to the port of Lagos from the intense action of waves and accumulation of fine sediments. Transport parallel to the coast has been interrupted and has led to entrapment of 0.5 to 0.75 cubic meter of sand per year behind the West Pier which meant that the "Light house" beach located on the western edge, has experienced strong accumulation while the downdrift part of the port entrance was experiencing a lack of sediment (Awosika et al. 1993).

1

2

Over the years, erosion on Bar Beach worsened by the effect of storm surges that have resulted into the removal of 250 to 500 m of sediments in some areas of the beach (Folorunsho, 2004). Indeed, high enough wave intensities occur each year between March and September. A monitoring station very close to the Federal College of Fisheries and Marine Technology has seen the crest of the berm eroded over 70 m in three months (from March to

June 2000) during a period of storm. By 1958, several protection options have been implemented to reduce the impacts of the construction of the Piers (groin, discharge of fine sediments, pumping stations). To avoid the impending collapse of commercial and residential buildings, federal and state offices and disruption of socio-economic activities in Lagos Island, the artificial nourishment formula was used until a nearly permanent solution to the problem is found. Following the call for tenders issued by the Federal Government of Nigeria to identify a sustainable solution to coastal erosion on Bar Beach, a conference of stakeholders was held in Lagos in 2005.

Table 2: Study on the erosion of Bar Beach: March 2000 - February 2001 Trends

Bar Beach erosion monitoring station	Change in the berm crest in march 2000 (m)	Change in the berm crest in June 2000 (m)	Change in the berm crest in February 2001 (m)	Cumulated loss of beach over 12 months (m)
• ONIRU	180	110	113	67
• Government liaison bureau	125	105	67	58
• Behind EKO Hotel	95	80	101	+6

The Federal Government of Nigeria has been the only funder of the artificial nourishment of Bar Beach since 1969. This is because constitutionally, only the Federal Government of Nigeria has the legal mandate and is responsible for the coastal zone. Artificial nourishment of the beach in Lagos has failed because of the absence of artificial nourishment activities scheduled for the stabilization of the rapidly eroding beach. Given the predominant erosion, the intense coastal dynamics and the low-lying position of Bar Beach, artificial nourishment programs must be carried out on average every two years to maintain balance. Moreover, it would have been necessary to ensure that the foreshore (parts covered, at least in part at high tide, and uncovered during low tides) have been properly lowered to allow dissipation of wave energy before it reaches the crest of the beach berm.

The beaches of The Gambia 3

In this country, the Government has invested about U.S. $ 20 million for artificial nourishment of a beach of about 100 m wide, especially in Kololi. The project was supervised by the Dutch engineering firm *Royal Haskoning*. The Gambia has opted for this soft technology in order to preserve the aesthetic integrity of the beach. The technical realization of this option has resulted in a loss of half of the imported sand in two years (Bromfield, 2006).

Table 3: Trends of erosion at the State House and Kololi (2000 and 2011)

	State House Banjul	Bar Seaview Kololi Point
Length of artificially nourished beach (2004)	2 km	1 km
Width of the nourished beach	120 m	150 m
Length of the beach in 2011	52 m	16 m
Erosion of the nourished beach over 7 years	-68 m	-134 m

Source: Adapted from Dodou Trawally

In conclusion, while being one of the solutions taking into consideration the dynamics of the coastline, the artificial nourishment of beaches has some drawbacks due to:

- The difficulty in finding suitable materials at a good distance
- The need for periodic replenishment (hence its high cost) associated with regular supply of sediment needed to offset the inevitable losses on beaches subject to erosion. In the Netherlands, where beach nourishment is now a routine practice, it is estimated that the average annual cost of one kilometre of recharged beach is equivalent to that of one kilometre of motorway.

The cost of this technique

- Bar Beach in Lagos is artificially replenished at intervals of 2 to 3 years which makes this solution **very costly** in the long term.
- The cost of 3 km of artificially nourished beach is estimated at **700 million naira** (or U.S. $ 2026.6 per linear meter) by the Lagos State Commissioner for the development of the waterfront (David Amuwa 2008).

Fact sheet 5

The restoration of dunes

Author: Mamadou DIOP

This method, also called offshore bar raising technique (at breccia zones), mechanical stabilization of sand and biological reforestation (or fixation) is meant to restore or create a new dune in the backshore. The dune ridge is essential for the protection and stabilization of a sandy shoreline. The quality of this technique lies in its use of natural processes that are responsible for the formation of this dune ridge. The tables below illustrate the characteristics, conditions of implementation and the challenges and constraints of this technique, which overall is very effective.

OPTION	CHARACTERISTICS	IMPLEMENTATION
Coastal dune ridge level raising	Installing fences parallel to the shore to trap sand	Establishment of two physical barriers (**frontal fences**) parallel to the coast line, separated by 5, 10 or 20 m depending on the slope, of minimum average height of 1.20 m and of permeability of minus 25 to 30% to better trap the sand deposited by sea currents and transported by saltation and by sea winds. The accumulation of these sediments of sand at the foot of these physical barriers (**frontal fences**) leads to their progressive burial and heightening of the coastal dune ridge at the targeted breach level. The recharge of the dune depends on the speed of burial of the frontal fence that is a result of the amount of sand deposited by sea currents and the aggressiveness of the wind dynamics of the sand. The placement of a fence above the first one will lead to the desired heightening of the dune ridge at the targeted breach.

OPTION	CHARACTERISTICS	IMPLEMENTATION
Mechanical stabilizing of the dune ridge	Establishing a wattle to stabilize the sand and allow reforestation	The reforestation of the dune ridge areas that have graded their natural level requires prior mechanical stabilization of moving sand. This operation is essentially based on the principles of windbreaks. Because the wind is a driving force that moves the sand grains according to their weight by flight, small jumps (saltation) or rolling (creep), the idea is to mitigate the speed force to **minimize** if not stop the movement of sand. This includes: • Segmenting the dune ridge with physical barriers (**counter-dune, or counter-dune fences**) of 1.20 m to 1.50 m minimum average height, of 25 to 30% permeability, and perpendicularly to the direction of prevailing winds. • Establishing side barriers (**fences**) perpendicular to the counter-dune fences to counteract the action of side winds that move sand, in addition to the prevailing direction winds on the slope of the dune. This forms a network of fences or **wattle** the density of which varies with the aggressiveness of the winds and the height of the dune. Usually, a wattle (the mesh size of which shall not exceed 50 m on its sides) will be sufficient to cope with the dynamics of the offshore wind and stabilize sand movement to allow its reforestation. The materials used for carrying out the work are branches from local woody vegetation (such as ***Euphorbia balsamifera, Leptadenia pyrotechnica, date palms, Typha, Indigofera oblongifolia, Prosopis juliflora, Balanites aegyptiaca***) which can be used depending on availability.
Fixing biologically or reforesting the dune ridge	Planting species adapted to the ecosystem	Planting will take place during the rainy season (generally in the month in August), when the junction between the residual moisture in the soil and moisture from the new rainfalls occurs. They can be made square at the rate of 400 plants/ha in combination or in staggered rows at a rate of 360 plants/ha. Each species is planted in the most suitable area for its development at the dune. Species selection will favour the use of local vegetation

OPTION	CARACTERISTICS	IMPLEMENTATION
Fixing biologically or reforesting the dune ridge	Planting species adapted to the ecosystem	that existed and/or still exist on the coast, or a similar ecosystem in the case of introduction of exotic species. This choice will take into account: - The adaptation of the species to the weather of the ecosystem; - The adaptation to halophilic soils; - The adaptation of species to sea spray; - The rapid growth of the species; - The adaptation to dune soils; - The ability of the species to develop in association with others. In this respect, the following species are generally used for carrying out this activity. ***Tamarix senegalensis, Nitraria retusa, Atriplex numularia, and Atriplex halumus.***

For these three techniques, the difficulty is to foresee the following bottlenecks:

- Inadequacy of materials for mechanical dune stabilization;
- Lack of close supervision by experts;
- Lack of systematic and regular monitoring;
- Lack of organization to produce a rigorous work.
- Use of species not adapted to the ecosystem;
- Rainfall deficit;
- Invasion of grasshoppers, termites and others;
- Lack of protection.

PRACTICAL EXAMPLES

The case of the coast of Nouakchott

The Mauritanian coast is an ecosystem, the reconstitution of the biological diversity of which requires specific activities and the causes of its degradation are often linked to climate or soil characteristic of the natural ecosystem. Indeed, repeated droughts and other climatic factors (reduction and uneven distribution in time and space of rainfall, shift in isohyets southwards, declining groundwater levels, etc.) that Mauritania suffered this past decade have caused the death of the vegetation adapted to this ecosystem. In addition, the coastal dune ridge and the coastal plain that delimits it have been used since the 1960s as sources of materials (sand and shells) for the construction and expansion of the city of Nouakchott. This unregulated and uncontrolled exploitation has caused the reduction of the natural level of the offshore bar and its destabilization. Techniques to fight against desertification and sustainable management of natural resources and environment have been developed. These ecosystem restoration techniques that are adapted to the Mauritanian context have the merit of being simple and inexpensive.

- The project for the *Rehabilitation and Extension of the Green Belt to Nouakchott* started work in 2000 and was completed in 2007: 800 ha of stabilized and fixed continental dunes were completed to enhance reforestation of previous years conducted between 1987 and 1992; 50 ha of mainland dune fixation and stabilization through participatory approaches involving the populations have been completed, together with a test of 7 ha for enhanced nourishment of coastal dunes, and fixing and reforesting the target area.

- The national component of the ACCC project in Mauritania has successfully led to the stabilization of 50ha of dune ridge in Nouakchott (the area between the wharf and the fish market) with sand trapping 1 and reforestation with adapted native species 2.

The cost of this technique

1 ha mechanically stabilized and biologically fixed: **4,184 U.S. $**

1ha covers approximately 600 linear meters

1 linear meter of mechanical stabilization of the dune is therefore up to U.S. **$ 6.97**

Fact sheet 6

Mangrove restoration as a defence against coastal erosion

Author: Mamadou Sow

In West Africa, the mangrove covers large areas and includes six species of mangrove trees, the most common being the Rhizophora - the red mangrove - and the Avicennia - the white mangrove. While providing valuable economic and ecological services (wood, reproduction and growth of marine animals, the stabilization of the coast), promoting the accumulation and fixation of marine sediments to reduce the impact of coastal erosion, and sequestering atmospheric carbon, the mangrove can also mitigate global warming and combat the phenomenon of sea level rise. Despite these applications, significant losses of mangrove areas are however recorded, due to the cutting of trees, construction of dams, dikes, roads and drought in the last thirty years. In six countries in the sub-region (Mauritania, Senegal, The Gambia, Guinea Bissau, Guinea and Sierra Leone) estimates show that the maximum surface of the mangrove on 3 million ha, has declined to 1 million ha in 1990 and fell down to 797,200 ha in 2007 (WCMC, 2007).

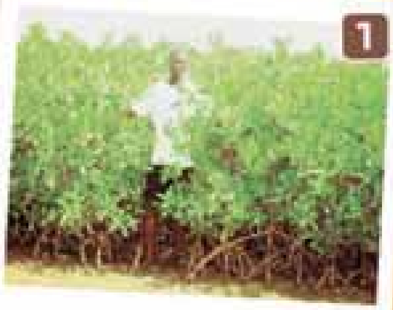
OPTION	IMPLEMENTATION
Reforestation with Rhizophora	Depending on the growth and multiplication requirements of the species, this type of reforestation should consider the following conditions: • **Hydrology**, including the frequency of flooding by the tide. The *Rhizophora* grows well in an area flooded daily by the tide or along the channels (bolongs). We shall seek to increase the volume of water submersion by opening small channels; • **The nature of the substratum:** clay is better than sand, generally poorer with a low capacity for water retention; • **The planting period** must be in the middle of the rainy season, when rains have neutralized the maximum salt in the soil and the substratum is very loose (potopoto). Furthermore, it is at this period that the seedlings (or propagula) - still on the mother tree - mature and begin to fall. • **Seedling quality:** good seedlings are greenish, with a nice bud and not damaged by predators such as crabs;

OPTION	IMPLEMENTATION
Reforestation with Rhizophora (more)	• **The planting technique:** 1/3 of the propagulum must be sunk, straight, into the mud (potopoto). The planting distance varies depending on the fertility of the substratum and the risk of seedling mortality. The principle is to plant densely when the mortality risk is high, such as a spacing of 25 to 50 cm between plants. On more fertile and less salty sites we can adopt spacing of 1 to 2 m; • **Stages of reforestation:** a tree-planting campaign is a labour-intensive work, which requires above all, a good capacity for maximum mobilization of stakeholders from all segments of the eligible population. Collection and transportation of propagula is the first step done the day before planting in order to achieve best results. Sorting and planting are done on the same day, the major constraint is the fact that planting is done at low tide. Three teams should be established to ensure: - Sorting of propagula, - The supply of propagula to planters, - Planting. • **Monitoring of plantations:** it is intended to assess the success rate of the operation and in case of deaths, to replace the plants. The growth rate which depends on the availability of fresh water and fertility of the substratum is also a parameter to monitor. Disease cases for the mangroves are rare.

PRACTICAL EXAMPLES

Reforestation on the Island of Djirnda in the Saloum (Senegal) 1

Annual campaigns began in 2003 with support from projects implemented by IUCN and JICA. In 2008 an area of 1.5 ha was covered by Rhizophora. Despite the modest size of the reforested area, this action has a considerable impact in motivating people who pursue the restoration through an association of women for reforestation who are extending the surface every year.



Reforestation at Gagué Sharif in the Sine (Senegal)

Several reforestation campaigns were conducted on this site, including by WAAME, JICA and UCAD. However, due to high soil salinity results are rather disappointing. Mortality is high and survivors' growth is slowed.

The cost of this option

- The cost varies from one country to another in the sub-region.
- By including the logistics for the collection of propagula and catering for the villagers, one reforestation day, mobilizing 100 people will cost 150,000 to 200,000 FCFA (about **U.S. $ 333 to 445**).

Fact sheet 7

Optimizing land use by planning options

Author: Dodou TRAWALLY

Beyond the hard engineering and soft engineering options, the size of the legal and administrative management of this land portion is a must. This section describes six options of land use as a management tool for controlling climate change induced coastal erosion, which are illustrated with the case of the Gambia.

OPTIONS	DESCRIPTION, IMPLEMENTATION AND CONSTRAINTS
Delineation of shorelines	A stretch of land from a dozen to a few hundred meters is defined to delineate the coastal zone to protect mainly against human interference. A rule must be implemented; a rigorous public awareness is necessary. Difficulties can arise for law enforcement and control of intrusions
Classification of shorelines	The classification or subdivision of the shoreline mainly occurs based on the biophysical conditions encountered. Technical capacities to define these limits and the availability of high resolution satellite images are required for this option. Local expertise and support tools, such as geographic information systems (GIS), are generally inadequate, forcing to call on external expertise.
Zoning of shorelines	The shoreline is classified into subdivision for different uses. The implementation of a regulation is necessary, together with a systematic awareness of the public, recognition of property rights and the involvement of all stakeholders. New infrastructure within these limits may be required. Difficulties sometimes arise in enforcing regulations and controlling the incursions of the public.
Buffer zones for coastal forests	Buffer zones are defined around the main forests to preserve their integrity. The enforcement of an appropriate regulation is necessary; so is the direct involvement of local communities for forest management and systematic public awareness-raising. It is sometimes difficult to enforce the implementation of buffer zones; new infrastructure for defining these areas may be required.

OPTIONS	DESCRIPTION, IMPLEMENTATION AND CONSTRAINTS
Displacement of activities and infrastructure	Activities and/or infrastructure are moved to prevent any problems. Appropriate sites for these activities or facilities must be identified. The new sites must be acceptable before displacements are planned, for if this is not the case, there is a risk of triggering legal disputes.
Acquisition of coastal lands	Unused or abandoned coastal land are acquired and converted to a beneficial environmental use, a new use in line with the ecology of the site. Local people must be involved in all decisions, and the direct management of the area is a requirement. It is essential to conduct studies on the new land use to prevent any risk of damaging the ecology of places.

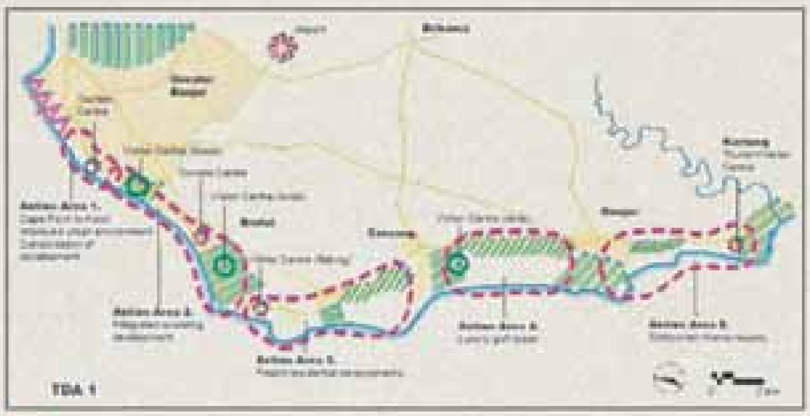
PRACTICAL EXAMPLES EN GAMBIE

Delineation of a stretch of land 150 meters wide along the northern and southern coasts is proposed as a way of fixing the shoreline where no new development will be allowed.

This shoreline has been divided into 9 plots based on physical conditions, to allow easier planning. 1

Zoning:
the entire coastal zone, including the shoreline, is divided into tourism development areas, where areas assigned to agriculture, fisheries, tourism, etc. are clearly defined. 2

1 **Coastal plots**
Source: Coastal feasibility study, 2000



2 **Tourism development area on the western coastline**
Source: Tourism master plan 2007

Buffer Zone:
The Gambian coastal zone has four forest reserves; however, none of them has a buffer zone

The systematic displacement of sand extraction places along the coast to avoid impacts such as increased coastal erosion has been instituted. 3

An unused sand pit has been exploited in the village of Kartong in the ACCC project to support local ecotourism. 4

3 **Displacement of sand pits**
Source: National Env. Agency, 2011


4

The cost of these techniques

SET BACK LINES
- Quite costly technique for setting limits, especially if the area is extensive. The cost of developing infrastructure depends on the type selected.

- The expert service for demarcation is **U.S. $ 150 /hour.**

CLASSIFICATION OF THE SHORELINE
- Quite expensive technique because of the remuneration of expertise and for the possible purchase of high resolution satellite images.

- The expert service depends on the number of man hours/day, usually **U.S. $ 150/hour.**

- Satellite imagery: for a resolution of 2.5 m/5m the high-resolution imaging costs **U.S. $ 7,500 to U.S. $ 10,500** for a full view.

ZONING
- Infrastructure Development, for example 1.5m-high concrete pillar used for demarcations costs about **U.S. $ 25.**

- The expert service for demarcation is **U.S. $ 250/hour.**

- High-resolution satellite imagery: **7500 U.S. $/image** resolution of 5m as an example.

BUFFER ZONES FOR COASTAL FORESTS
- High resolution satellite imaging: **U.S. $ 7500/ image** resolution of 5 m as an example. The expert service for demarcation is **U.S. $ 150/hour**

- The costs of monitoring to maintain the buffer zone; monthly salaries of **U.S. $ 80/month/person.**

DISPLACEMENT OF ACTIVITIES
- **High cost**, because this option requires the development of new infrastructure and may also involve compensation.

- **Significant costs** for infrastructure such as roads and buildings.

- Potential compensation.

- This can trigger legal disputes if the parties do not want to move their operations.

LAND ACQUISITION
- Could mean developing new infrastructure and therefore relatively expensive.

- Infrastructure such as access roads, the boundary fences, etc. For example the cost of fencing at Kartong over about 250m stood at **U.S. $ 5.500.**

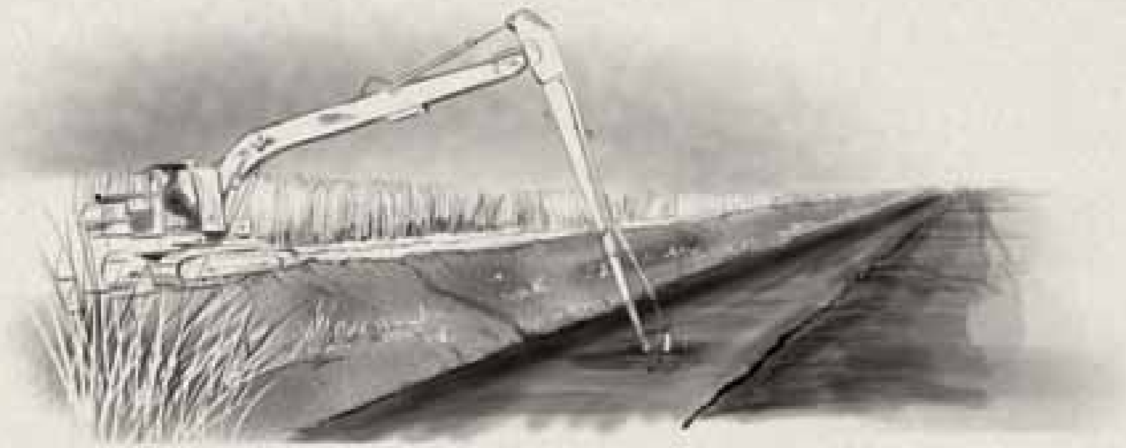
- Unskilled labour.

Fact sheet 8

Water resources management to fight against climate change impacts

Author: Serigne FAYE

Most countries in sub-Saharan Africa are in conditions of severe water stress that will increase significantly. Human activities and natural disturbances also contribute to the disruption of water cycle with additional indirect effects. The main threats to water resources for men are related to water pollution, to its scarcity and most importantly, to global climate change the impacts of which are reflected in terms of rainfall distribution, the sea-level rise, changes in the absorption of CO_2 by the oceans, and increased extreme rainfall events. The consequences of climate change on water resources will also have more impact in the sub-region because of the geographical position of the coast, low incomes, lack of technology and weak institutional capacity to adapt to fast changes. There is also greater dependence of the populations on sectors related to natural resources that are very sensitive to climate, such as water resources and agriculture.



Climate, water resources, biophysical and socioeconomic systems are so intricately interconnected that a change in one of these elements will lead to "domino effect" on others. It is therefore expected that the vulnerability will vary across countries or regions, depending on the geographical position and the ability to mitigate or adapt to disturbances. To cope, adapt and build resilience in sub-Saharan Africa relating to the impacts of climate change on water resources, it is necessary to adopt a holistic and integrated approach involving the consideration of risk management systems and strategies. Solutions include urgent actions based on technology, science and innovation, but also on good indigenous (or local) adaptation practices. Science, technology and innovation need not be expensive or complex, but must allow a certain sustainability of water resources.

OPTIONS	CHARACTERISTICS AND IMPLEMENTATION
Small breakwaters	Concrete is recommended as a building material in the case of small rivers influenced by tides and saline water intrusion and has many advantages, including: • To avoid the intrusion of saline water, • To Create water reservoirs for irrigation, • To maintain a given level of the river, • To allow the restoration of soil by pushing water through floodgates, and • To increase infiltration into aquifers
Transfer of water flow from a river	This technique can be done through natural or artificial canals, or pipes from natural or artificial water supplies. It may be done by gravity depending on the topography of places or by pumping. This technology allows irrigation in sensitive areas nearby catchment areas; it has the advantage of: • Rehabilitating the soil, • Extending pastoral and agricultural practices, • Improving groundwater recharge. Topographical studies to identify the best sites are to be planned; the involvement of local people through community awareness and capacity building so as to avoid conflicts over water use is paramount.
Construction of retention pond/ artificial lake/ provisional ponds	This technique is relevant to low and coastal environments insomuch as it meets water demand and availability for a few months after the rainy season; it may allow irrigation and pastoral activities in conditions of climate change and variability. Another benefit is recharging of groundwater. The use of topographical studies to determine the best sites and community awareness is also appropriate here.
Rainwater harvesting, storage and conservation	Since the supply of quality drinking-water is a major problem linked to climate change, the promotion of an efficient drinking water storage and conservation system in coastal areas with salty/polluted water or water that is hazardous to health (presence of fluorine, chlorine or arsenic) is necessary: the harvesting of rainwater from roofs, connected to a reservoir for storage and conservation are a soft option to be implemented in rural areas, affected by salinization. This soft and inexpensive technology can be used as well in rural areas where drinking water requirements are low. The implementation of conduit systems along the edge of roofs, as well as a tank for storage and conservation of water must be provided.

OPTIONS	CHARACTERISTICS AND IMPLEMENTATION
Small protective walls of sand	In coastal areas, in rivers and estuaries: the construction of simple piles of sand stabilized by vegetation and sometimes by encroachments which serves as a barrier. The height and length of the walls depend on the chosen locations: they must be based on the configuration of the watershed, the slope of the terrain, the topography, flow conditions and specific goals. The benefits of these walls include: protection against the mechanical action of water, stopping the salt water intrusion into rivers, salted soil improvement to allow rice farming, the prevention of floods, the creation of water reservoirs for irrigation, infiltration into aquifers.
Modern seawalls	For small flows; built of concrete: this type of infrastructure is put in place to prevent the intrusion of saline water or create a water reservoir for irrigation. This option requires an engineering work provided by specialized firms.

It may also be considered to further promote traditional local coping strategies that offer solutions put into practice in many areas of the sub-region. It would be important to assess, improve and apply them to other localities. They are multifaceted and include:

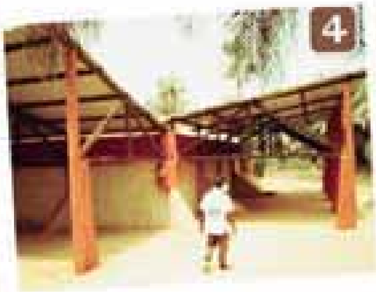
- **Improving the effectiveness of the use, conservation and distribution of water** through the promotion of **micro-irrigation** and **drip irrigation** to improve lifestyles and ensure food security;

- **Recycling wastewater** (stabilization ponds) for irrigation and groundwater recharge;

- Promoting **low cost sanitation** to protect water resources;

- **Promoting the social value** of water at the grassroots level by increased **awareness-raising** and **education**, but also in promoting **integrated management of coastal zones** and **climate change mainstreaming** (forecasts and early warning systems) in the integrated water management;

- Developing **mangrove ecosystems and protected wetlands.**



PRACTICAL EXAMPLES

Some examples are listed below and illustrated from 1 to 4 pages 34, 35:

1 Sand dam consolidated by local vegetation at Loul Sessene (Fatick).

Sand dam reinforced with shells at Nyassia in Lower Casamance.

2 Modern concrete seawall at Loul Sessene (Fatick).

3 Small concrete seawall with outflow at Nema Ba in the Saloum.

Artificial canal at Richard Toll (northern Senegal).

Rainwater harvesting pond in Nianing/Mbour, Senegal; the retention ponds program provided successful examples that ensure water availability during 3 to 6 months after the rainy season.

4 A 350-cubic-meter tank in the village of Kailo, in the Bliss and Karone islands.

The cost of these techniques

Small dams

- **From 700 to 800 U.S. $** per linear meter: costs depend on the size of the river, the tank capacity, the flow and condition of the river.

Transfer of water from a river

- **U.S. $ 5 to 50**, the lowest linear cost which may be valid if natural conditions of the terrain are favourable (gravity drainage and natural reservoir). The cost varies depending on the type of tank, the distance to the source, the transfer mode (gravity, pump), and participation of local people;

Construction of retention ponds/artificial lakes /temporary reservoirs

- Can be up to **U.S. $ 60,000** for a 100,000-cubic-meter tank. The cost depends on the size of the tank and the local geomorphology.

Rainwater harvesting, storage and conservation

- **U.S. $ 800 to 900** for a 20-cubic-meter tank.

Small sand bunds

- Unit costs can be significantly reduced if we use the experiences and the involvement of local people and if we use local materials and rudimentary elements.

Modern seawalls

- U.S. $ 300 to 500 minimum per linear meter.

Fact sheet 9

Protection of marine ecosystems through biological recovery

Authors: André BIHIBINDI - Ndiaga DIOP

Protection and conservation of marine and coastal ecosystems, particularly with respect to the impacts of erosion exacerbated by climate change, are necessary for many reasons because:

- **They provide habitat for fish resources**
- **They ensure the sustainability of these resources to levels that sustain their continued availability,**
- **They contribute to the reduction of extreme poverty in fishing communities through the improvement of trade, job creation and food availability;**

Biological recovery is one measure that can be implemented in the field of fishing. It consists in suspending fishing activities during a renewable period of time through sustainable community management of fisheries resources. This rest is instituted in areas most at risk, characterized by an intensive exploitation that results into the depletion of fisheries resources. The biological rest is for preserving the biological parent stock of species and to ensure recovery of the stock under normal, natural conditions, without fishing.

OPTION	IMPLEMENTATION
Biological recovery	The biological recovery is usually considered when it comes to mono-specific stocks such as octopus, bars, tiger prawns, etc. It is essential for managers to know the following in advance: • The biological parameters (breeding area, breeding season) of the resources involved in the biological recovery, • The delineation of sensitive areas of reproduction, nursery, fishing for the species concerned and • Identification of the critical exploitation period or the fishing gear targeting these resources will be the next steps. At this stage the economic cost shall be estimated and supportive measures proposed for stakeholders (fishermen, ship-owners, industrialists, government). Only on the basis of all this information, shall we proceed to develop a regulatory framework and establish a monitoring system during the closed season for the target area.

PRACTICAL EXAMPLES

In Senegal

On order of the Ministry of Fisheries (dated November 2009), annual periods of rest called biological recovery in waters under Senegalese jurisdiction have been established for industrial fishing vessels.

Mauritania and Morocco

The introduction of biological rest is regular because the exploitation of fisheries resources focuses on mono-specific stocks (octopus, crayfish, lobsters, sardines). Since the 2000s, fisheries managers in both countries establish each year, a biological rest period of two months renewable according to the biological characteristics of species.

In Guinea

As in most countries of West Africa, commercial fishing focuses on multi-specific stocks where the various species do not have the same biological parameters; in this case, other fisheries management measures are used, (fishing licenses, quotas, gear mesh, marketing size, etc.).

Fishing of octopus and cymbium (yet in Wolof) in the villages of Nianing and Pointe Sarene

Nianing and Pointe Sarene are two villages on the southern coast of Senegal, also known as the "Petite Côte", wide open on the Senegalese coast. They are among the richest fishing communities of the country because the *Petite*

Côte is a spawning and nursery area for many species due to favourable dynamic marine conditions. It houses the largest fishing port in Senegal which provides more than 70% of all landings. However, this part of the coast of Senegal is also marked by the development of other activities such as tourism that builds on the importance of beaches located in the area and the favourable coastal climate that prevails. It is characterized by:

- An abusive exploitation of fisheries and coastal resources in fishing sites. Despite the existence of a code of fishing and legislation on the management of maritime public domain in Senegal, compulsory measures are not applied in most cases. The fishermen are using fishing gear that degrade the marine environment and cause a depletion of fish products while demand is increasingly growing. There is a considerable increase in the number of fishing boats and fishermen, particularly because of the recurrence of drought, and the unrestricted access to the resource, thus increasing the fishing effort while fish stocks suffered a general decline in recent years.

- The development of seaside tourism, the occupation and exploitation of the coastal stretch in various forms are exacerbating the degradation of the mangrove, coastal erosion, and hamper the development of many species, including turtles that bury their eggs in beach sand. These aspects are major constraints for the balance of the marine and coastal ecosystems.

1

In 2003, fishermen in Nianing and Pointe Sarene have invested in **sustainable community management of fisheries resources** with the support of researchers, state technicians and development partners to reverse the trend 1. They have taken measures to adapt to increasingly changing environmental, economic and demographic contexts. They were able to establish a biological rest period for octopus and cymbium, both major income-generating produce. The rest period is from September 20 to October 20 of each year, which is the breeding season of octopus on the *Petite Côte*. The observance of the biological rest is accompanied by immersion of clay-pots in which the octopuses lay eggs. During this period, many cymbium newborns are collected along the protected coastal stretch and carried into the sea. The observance of the biological recovery has become possible, since the idea came from local fishermen, because of the importance of using their experience and knowledge in fisheries management. Indeed, the participatory approach in fisheries management is more advantageous than the centralized approach in terms of cost of labour, and hence suitable for developing countries where public finances are facing severe difficulties.

Several factors explain the success of this initiative. Fishermen have established a code of conduct for the exploitation and management of fisheries resources. This code of conduct approved by the Prefect of Mbour is enforceable against third parties. They also benefited from the support of the departmental service of fisheries, researchers and development partners. During the closed season, a majority of fishermen undertake **rainfed agriculture and poultry farming**, while others continue fishing but outside the usual areas. Thus, the creation of income generating activities especially in the closure season helps to reduce the pressure on fisheries resources while ensuring the maintenance of family income. Octopus and cymbium proliferate therefore; the captures are of good size; fishermen do not fish much, but they sell better over a longer period.

Economic assessment of this option

With this initiative, the players have shown their ability to adapt through their local knowledge, and to organize with a view to generate a positive economic balance (see Table 4).

Table 4: Information on the assessment of the economic effects of this option

Activities	Estimated monetary value (in US$)
Seasonal closure of fishing for octopus	-32,627
Seasonal closure of fishing for cymbium	-7,078
Reducing the number of gillnets	-13,765
Marketing of octopus	99,529
Commercialization of cymbium	88,529
TOTAL	**134,588**

Source: GIRMAC - JICA 2006

Fact sheet 10

The Marine Protected Areas (MPAs)

Author: Charlotte KARIBUHOYE

Marine protected areas (better known by the acronym MPAs) are demarcated areas within or near a marine environment. They are set by legislation or other effective regulatory means; they may include seas, oceans, estuaries and coastal areas that ensure the protection of plant and animal resources associated with them. They are increasingly seen as an effective means of contributing and facilitating the conservation of natural resources and heritage of natural ecosystems. This protection measure provides appropriate and inexpensive responses to the challenges of climate change. Their ecological merits due to soil and biodiversity conservation, protection against erosion, regulation of water flow and quality, is coupled with their ability to contribute to carbon sequestration. The contribution of MPAs is also significant in terms of socioeconomic development of communities, who benefit from the impacts of improved natural resource management. Also serving as effective protection against natural disasters (floods, hurricanes and tsunamis), protected natural ecosystems constitute a real complement (or substitution) to some much more expensive investments (infrastructure) for the protection of coastal sites.

The success of this option in fighting against coastal erosion depends on several factors including:

- The various levels of protection, ranging from strict natural reserves areas to sustainable exploitation areas;
- Defining the limits and rules of management, ideally known and accepted by all stakeholders, in terms of access and exploitation of marine and coastal space and resources;
- The identification of areas at risk of erosion; the causes must be clearly established;
- The establishment of buffer zones around sensitive sites in order to limit resource extraction updrift these fragile ecosystems;

- Sufficient means of management available for their enforcement (surveillance and monitoring, information and communication, facilities...);
- The establishment of a governance system for the effective involvement of stakeholders (communities, users, government...) in MPAs management and in decision making.

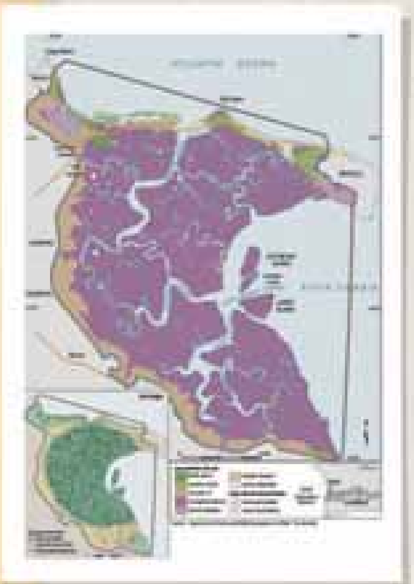
The implementation of supportive measures, including the development of income generating activities to help reduce pressure on sensitive resources. It is also important to note that since the MPAs can often protect the last remnants of natural habitat, the latter must be included in areas of enhanced protection to maintain their resilience. This protection of the most vulnerable sites ensures their natural regeneration that could be reinforced by other complementary actions, such as habitat restoration, replanting of trees, etc.

OPTIONS	IMPLEMENTATION
Marine Protected Areas (MPAs)	Clear objectives and a well defined space, with management rules known and recognized by the various actors are needed. • The identification of areas vulnerable to erosion and/or sites still ear-marked to protect as part of the implementation of MPAs • The involvement of all key players in the implementation of measures, including local communities, officials from the central level, but also external users who exploit space and resources in and around targeted sites. An integrative approach that combines at the best, not only the different categories of actors, but also the various modes of practice and various interests. • The availability of the necessary means for the effective management of the site. • Regular monitoring of the site and the implementation of adaptive management measures if needed. The formal establishment of AMPs at the regulatory level is not sufficient if the site management measures do not reduce pressure on sensitive resources and maintain the proper functioning of ecosystems. This sometimes requires the mobilization of significant human and technical resources, in addition to a strong political will that are unfortunately not much available. • In addition, although the reduction of risk factors induced by human activities must be accompanied by **concrete measures to promote alternative income generating activities for the benefit of communities** dependent on coastal resources, an investment and a long term vision are needed to achieve and maintain the necessary level of protection. • Finally, the establishment of an MPA should be included in a more holistic approach to coastal zone management, taking into account the various development sectors and the interests of all stakeholders with a view to minimize any risk of conflicts.

PRACTICAL EXAMPLES

There are still rare examples of MPAs currently in place to fight against coastal erosion and climate change. Some practices have nevertheless revealed to be convincing in some particularly sensitive areas which are described in the following examples.

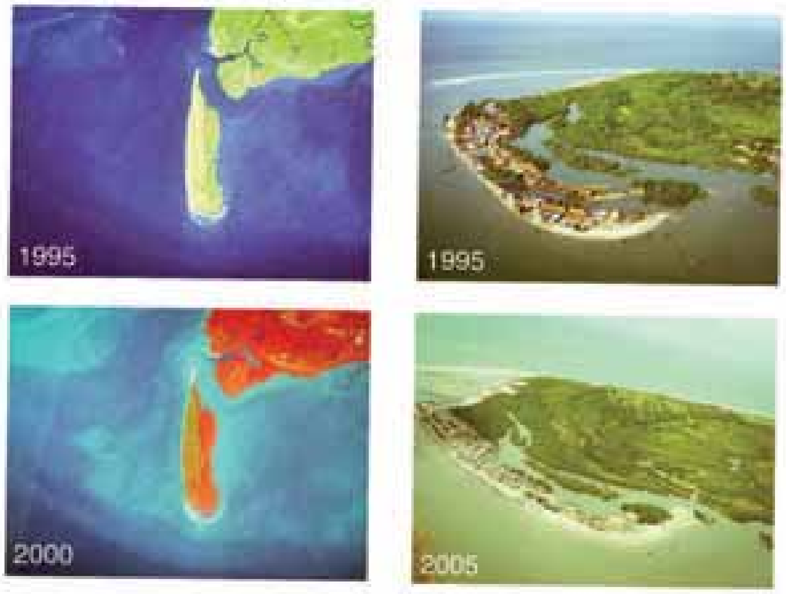
Tanbi National Park in The Gambia



Located at the mouth of the Gambia River, between the cities of Banjul and Kanifing, the **Tanbi National Park** is a wetland of international importance, consisting mainly of mangrove swamps and is bounded on the north by the Atlantic Ocean and on the east by the River Gambia. Due to its characteristics and location, **this park plays an important role for biodiversity conservation and the reproduction of many marine species. But it is also known for its effects on the stabilization and protection of the coast against coastal erosion.** This is also a highly valuable element given the vulnerability of the city of Banjul, and The Gambia as a whole to the impacts of climate change. This significant contribution is also partly reflected in the management of this MPA as activities of habitat restoration (including fighting against erosion and salt intrusion, but also for the preservation of a central swamp) are organized. Mangrove cutting and infrastructure development are prohibited. Landing is also forbidden on three central islands. However, with urban growth and the development of various activities related to economic development, this site is more exposed to the threat of the spread of urban areas. These increasing human pressures are threatening the integrity and operation of the site. This is how we should understand the approach of the ACCC project which was to contribute to the delimitation of the park.

The Porcos Island in Guinea-Bissau

Porcos Island, located south of Carache Island and northwest of the Bijagos archipelago, is classified as a biosphere reserve (BR). It covers three marine protected areas and countless sacred sites traditionally protected by local communities of the Bijagos ethnic group. This island, formerly a nesting area for sea turtles, is rich in fishery resources and mangroves. Given the vulnerability of the Porcos Island, the need to preserve its ecological and socioeconomic value was reflected in the zoning of the Bolama-Bijagos biosphere reserve. The island is part of the central zones of the BR, where a more severe restriction of human activities is considered (limiting human settlements, tourist facilities, fishing camps, mining...). In principle, only the local traditional activities which have low toxicity to the environment are



permitted. However, like other sites in the archipelago, this island has been under considerable pressure, particularly because of its massive occupation by illegal camps home to hundreds of people (mostly fishermen from neighbouring countries such as Senegal, Sierra Leone, Ghana and Guinea). This massive occupation has resulted in an exacerbation of coastal erosion, especially due to unbridled exploitation of mangroves for fish smoking, among others. A portion of the island (the cape) has consequently disappeared as shown in the following images. As part of strengthening the management of the biosphere reserve, steps have been taken to end this illegal occupation. The dismantling of settlements in 2008 has greatly reduced the pressure on the island, including erosion. Regular monitoring of the site is necessary to assess its evolution, particularly the regeneration of mangroves and the reduction of erosion.

The cost of this technique

The specific costs for the AMP option in fighting against erosion are difficult to estimate as this option must be part of a global system of the MPA management. The establishment and management of an MPA usually involve a long process and several steps, costs of which will depend on the objectives of establishment, duration, location and size of the site, the complexity of its management, etc.

- The minimum cost of an MPA establishment over a period of 4 to 5 years is between € **20,000** to more than € **3,000,000** depending on the circumstances, the size of the MPA, the scale of investments at the start and duration of the process.

- For the operation, costs depend on the complexity of management. Monitoring costs in particular can be very high in highly used MPAs but other activities (ecological monitoring, communication, and various facilities to support local development) can also be expensive.

- Available data on MPAs in the West Africa sub-region indicate costs ranging from **1 to 32 €/ha**. In community MPAs where the surveillance and monitoring are often the result of local populations, costs can generally be lower per hectare than in the case of MPAs managed by institutions.

What to choose?

The Fact sheets 1 to 10 described the technical characteristics of major options, the most commonly encountered and their costs. These characteristics are coupled with steps required for monitoring and maintenance, in particular for the hard-engineering options which are summarized in this section.

The benefits of regular monitoring of coastal management are generally well understood by engineers and other stakeholders. Although it entails some costs, it also generates the most benefits for the following reasons:

- The acquisition and analysis of long-term data through regular monitoring (e.g. beach profile) may be cheaper and more reliable than intensive short-term measures or modelling;
- It provides warnings about existing problems before they become serious and expensive to repair;
- It facilitates performance evaluation of existing defence systems to allow successive improvements under the management strategy.

To ensure effective coastal management, monitoring should be extended. It should include such essential data for engineering factors as:

- Conditions of swells and tides;
- The winds;
- The sediment supply;
- The rising sea level;
- Flood risks associated with marine and hydrological factors.

Less obvious characteristics such as ecology, water quality, impacts of sand and gravel mining may also require monitoring in certain circumstances. The value of these new data in most cases depends on the time available for recording and duration of these recordings. For this reason, and given the fundamental importance of planning and designing, the recording of data shall begin at the earliest. Very often, the need to respond to an urgent need leads to a too short time being devoted to work to allow the acquisition of good quality data and over an adequate period of time, which is however a prerequisite for long-term coastal monitoring programs.

An impact assessment of existing conditions on the site and of infrastructure works in coastal areas during the construction period and beyond is also required. This step assesses the positive and negative impacts in order to determine the effectiveness of the various project components for achieving the goals and objectives of the project. The assessment will provide customers, signatories of contracts and other stakeholders with useful information about the primary objectives in order to solve the problems of coastal erosion, and land degradation, including the destruction of infrastructure and loss of private and public properties at the site and surrounding areas. In the case of beach revetments for example, it is paramount to assess the impact of energy dissipation and the run up of waves or their overflow on the structure and adjoining areas, and the sediment supply. Regarding the groins, the effectiveness of the structure to stabilize the shoreline (meaning, the effectiveness of the ability to trap sand) is very important. It is equally important to assess the impact on areas downdrift the groins for instance.

What decision to make? Based on the evidence provided in this guide, we hope that policymakers will be better equipped to take action. To perfect their approach, we are proposing the following table which provides an overview of positive and negative impacts and costs associated with the different options.

Table 5: Summary of impacts and costs of adaptation options in coastal areas

HARD ENGINEERING OPTIONS	POSITIVE IMPACTS	NEGATIVE IMPACTS	COSTS
1. Seawalls	👍👍👍	👎👎👎👎 ⚠️	💰💰💰💰💰💰
2. Groins	👍👍👍	👎👎👎	💰💰💰💰💰💰
3. Beach revetment	👍👍👍	👎👎	💰💰💰
SOFTER ENGINEERING OPTIONS			
4. Artificial beach nourishment (or replenishment)	👍👍👍	👎👎👎	💰💰💰💰💰💰
5. Restoration of dunes	👍👍👍👍	👎👎	💰💰
6. Coast fixing through mangrove restoration	👍👍👍👍	👎👎	💰
INTEGRATED RESOURCE MANAGEMENT			
7. Optimizing the use of coastal lands	👍👍👍👍	👎	💰💰
8. Integrate management of water resources	👍👍👍	👎👎	💰💰💰
9. Biological recovery through sustainable, community-based fisheries resource management	👍👍👍	👎👎👎	💰💰💰
10. The role of Marine Protected Areas (MPAs)	👍👍👍👍	👎	💰💰💰

In terms of cost/benefit analysis, the results are mixed, especially because of the risks of "*maladaptation*" (a change in natural or human systems leading to increased vulnerability instead of reducing it as defined by the IPCC) generated by the seawalls option. The natural dynamics of beaches is the result of many natural parameters such as waves, currents, tides, wind, soil erosion plus the rise in sea level, as explained in previous sections. When it is under no stress from human activity, the natural evolution of a beach depends on the dynamics of the beach itself, which gradually absorbs the wave energy. Seawalls are a striking example of option with low cost/benefit yield, because although they offer immediate protection, which is the goal often sought by policymakers, the erection of walls affects these dynamics as they are a barrier increasing the reflection of waves and hence their impacts and erosion. This entails a loss of front beaches and further erosion at the end of these structures. Hard defence structures tend most often to oppose, or hinder coastal processes, thus inducing many adverse impacts (collapse, transfer of problems with exacerbation of coastal erosion, etc.). These hard engineering options are also the most expensive ones, even if the cost of revetment is relatively lower.

These physical phenomena explain the fact that the most cost-effective options in the control of erosion, with a smaller negative impact on the coast, are soft defence structures that act in harmony with the natural dynamics, or the least disturb them. The high cost of artificial beach nourishment, however, must be highlighted, although interesting results were obtained with that option. These costs are mainly due to the fact that the operations of artificial nourishment should be regularly maintained. The other two soft engineering options generate interesting results at lower costs.

As for the four management options, they generally produce positive effects (as they help in better management of resources in an integrated manner). However, one should bear in mind that they also have a cost though much lower than the costs of hard-engineering options. However, they are of additional interest to the populations, since they all involve a participatory approach.

Authors, contacts and references

FACT SHEET N°1

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FACT SHEETS N° 2 et 3

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FACT SHEET N°4

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FACT SHEET N°5

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FACT SHEET N°6

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FACT SHEET N° 7

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Summary of impacts and costs of adaptation options in coastal areas

HARD ENGINEERING OPTIONS	POSITIVE IMPACTS	NEGATIVE IMPACTS	COSTS
1. Seawalls	👍👍👍	👎👎👎👎 ⚠	$$$$$
2. Groins	👍👍👍	👎👎👎	$$$$$
3. Beach revetment	👍👍👍	👎👎	$$$
OPTIONS NON STRUCTURELLES			
4. Artificial beach nourishment (or replenishment)	👍👍👍	👎👎👎	$$$$$
5. Reconstruction of dunes	👍👍👍👍	👎👎	$$
6. Coast fixing through mangrove restoration	👍👍👍👍	👎👎	$
GESTION INTEGREE DES RESSOURCES			
7. Optimizing the use of coastal lands	👍👍👍👍	👎	$$
8 Integrated management of water resources	👍👍👍	👎👎	$$$
9 Biological recovery through sustainable, community-based fisheries resource management	👍👍👍	👎👎👎	$$$
10 The role of Marine Protected Areas (MPAs)	👍👍👍👍	👎	$$$

About the ACCC project

Five countries in the West Africa region, namely Cape Verde, The Gambia, Guinea Bissau, Mauritania and Senegal, facing problems of coastal erosion have asked UNESCO/IOC in 2003 through a request from SINEPAD to develop a project proposal for funding by the UNDP/GEF. After approval by GEF in late 2004, the ACCC project began in 2005. Its objective is to identify along eroded coastlines some pilot actions for the protection of sensitive areas and formulate a priority program to implement them as part of an integrated management approach. In addition to identifying priority sites and actions, the project focuses on the causes, socio-economic and environmental impacts, existing legislations, past experiences of protection and future projections in the short, medium and long term, related to climate and coastal changes in the region. The planned measures were discussed in consultation with local and national inter-ministerial committees. The project addressed issues specific to each country as well as the regional dimension due to similar environmental conditions with an eye to sharing experiences for building the most adapted response possible to climate and coastal changes in West Africa. This manual is the result of a taskforce of national experts set up as part of this project.