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Countermeasures for controlling coastal erosion : case study of Senegal

Keywords: Coastal erosion, climate changes, shoreline, Senegal

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Introduction

Coastal erosion is a global problem; at least 70% of sandy beaches around the world are recessional (Bird, 1985, Zhang et al., 2004). The occurrence of high and/or variable rates of coastal erosion is not a recent trend in the Arctic (Mackay, 1986), however its significance has increased as more permanent facilities have been built in response to community expansion and increasing demand for Arctic resources (H. Lantuit, W.H. Pollard. 2008). In 2011, Japan was considered to be the best prepared nation on earth to withstand a large tsunami attack on its coasts however the unexpectedly large magnitude of the Great East Japan Earthquake destroyed many sea defense structures (Raby et al, 2015). The first global vulnerability and adaptation (V&A) evaluate the impacts of a 1 m sea level rise on the world's coastline (Misdorp et al., 1990, Niang et al., 2010) and ranked Senegal first of the 45th most vulnerable countries (out of 181 coastal countries). Senegal is situated on the western point of the African continent. The country is bordered to the west by 700 km of the Atlantic Ocean. This study discusses the countermeasures planned to be undertaken in Senegal and more especially in Saly.

Methods

The current situation of the site (about 4.5 km) is shown in **Figure 1**. The available options of shoreline management to deal with erosion problems are:

- to accept retreat in areas where beaches and dunes are wide and high;
- to maintain the coastline at a fixed position by hard structures and/or by soft nourishments (Rijn, 2011).

Other significant countermeasures to protect the coastline include also reforestation.

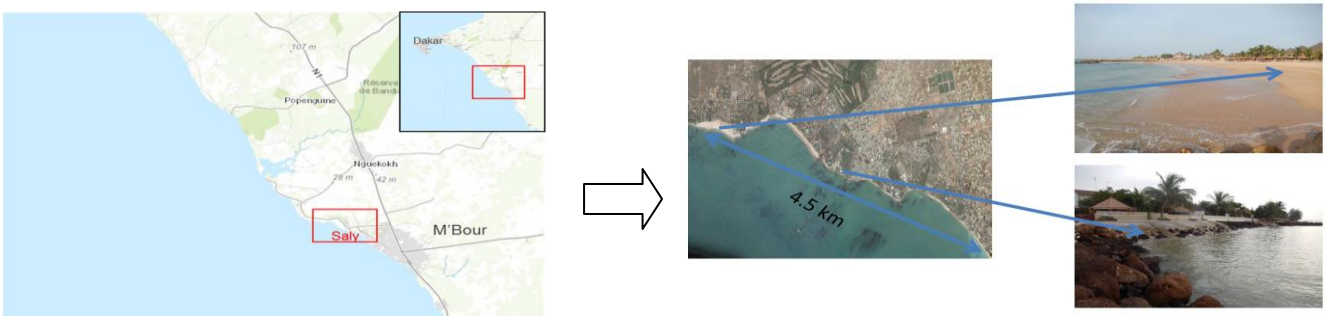

Figure 1: Current situation on the site (Egis, 2016)

Data collections and analyses were carried out on the area. There are 2 seasons in Senegal: the dry season (November to June) and the wet season (July to October). The evolution of the average temperature between 1979 - 2010 is depicted in **Figure 2** and the average during 2000-2010 is 27.4°C. Temperature changes have an effect on the evolution of sea-level. The altimetry along the coast is low and is around +2/+3m. The characteristics of the sizing swell are that H_s= 1.87m, T_p= 17s. The wavelength of the swell is 115m in front of the work. The majorities of the sediments are uniform and show a mode centered on fine sands or medium sands.

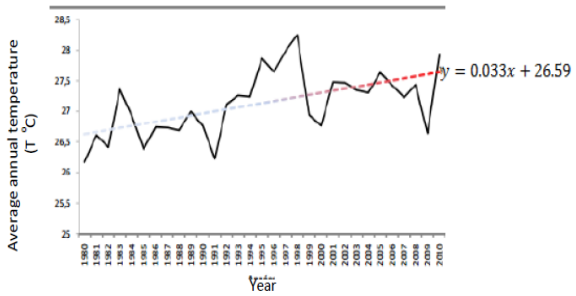

Figure 2: Temperatures evolution at the station of Mbour (Egis, 2016)

In Saly, it is not possible to accept retreat due to urbanization around the coastline. The solution proposed in the municipality of Saly is a combination of hard engineering structures (groynes, breakwaters) and sand nourishment on a line of 4.5 kilometers.

An evaluation of the effects of the developments on the swell and on the coast is carried out using MOPLA software. The entire model of “Morphodynamic of beaches” (MOPLA) is a program that allows us to simulate, in a coastal zone, the wave propagation from deep waters up to the coastline. From the wave results, the calculation of the currents induced in the surf zone, and the simulation of the morphodynamic evolution of the beach are made (GIOC, 2003j, Gonzales et al, 2007).

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Results

The proposed changes will have an impact in the phenomenon of the erosion in the area of Saly. The level of calculation is the extreme level with the characteristics in **Table 1**.

Table 1: Calculation water level

	Level of water	Centennial overhang	Increase in sea level by 2030 (global warming)	Extreme level by 2030
Height of extreme levels (m)	1.9	0.7	0.2	2.8

The results of analysis are shown in **Figure 3.** As is apparent, it shows that the implementation of breakwaters generates a strong attenuation of the swell heights at the coast. This technical solution consists in favoring breakwaters to protect the shore against the swell and block the sand nourishment. The groynes are built in some parts to prevent sand nourishment to follow the coastal transit of sediment (parallel to the coastline).

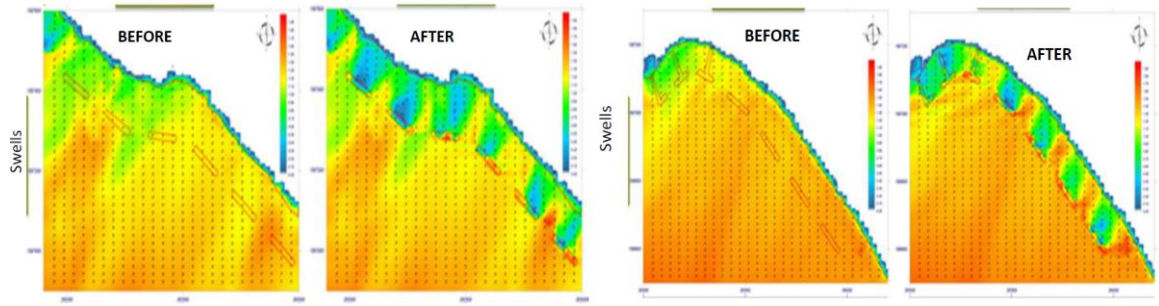

Figure 3: Results of the modeling with MOPLA (Egis, 2016)

Conclusion

Through this study, we noticed that there are several means for the defenses of the coasts but there are no universal solutions. Each case must be examined according to its specificities in order to propose a suitable solution. In Saly, a combination of hard structure and sand nourishment is proposed to reduce the advance of the sea. The results of the numerical modeling show the decline of water level after the structures and therefore the improvement of the phenomenon of the coastline erosion. However, a periodic maintenance program is recommended to ensure a sufficiently wide range.

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