AN INTEGRATED COASTAL MANAGEMENT STRATEGY FOR THE SAINT-LOUIS REGION, SENEGAL;

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INTRODUCTION

The Senegal river delta is vulnerable to inundation during the rainy season. To avoid widespread inundation in 2003 of Saint-Louis (Figure 1), the authorities decided to expel the surplus of river water by creating an artificial breach 7 km south of the city, through the Langue de Barbarie sand spit (Figure 2). This avoided large-scale inundations of the city, but the artificial breach grew uncontrollably during the subsequent years and became the new river mouth. This altered the dynamics of the lower river delta and continued to affect local villages, fishery activities, agriculture, and nature reserves. With the natural southward migration of the river mouth at a pace of ~500 m/yr, the population subject to flood risk by 2050 is estimated at 178,300 inhabitants for a 100-year flood. The Government of Senegal has asked the consortium Egis - Deltares to propose a sustainable and long-term management strategy for the lower Senegal river delta (PROGEP project).

Furthermore, an ongoing follow-up study (SERRP project) focusses on coastal erosion in front of the urbanized area of Saint-Louis and rainwater flooding. Erosion is a recurrent problem which has severe impact on the buildings and inhabitants along the waterfront. Short- and long-term development solutions are urgently needed to halt the erosive trend and protect residents and their property. Here, the project approach, results of various scenarios and recommended solutions are presented.

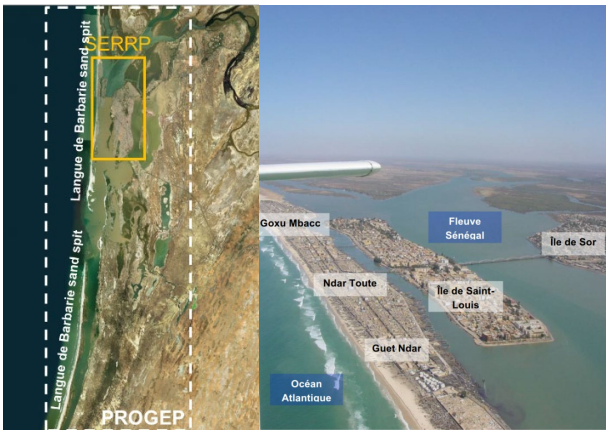

Figure 1 - Left: study sites PROGEP and SERRP. Right: most important districts in city Saint-Louis (BRLi, 2008).

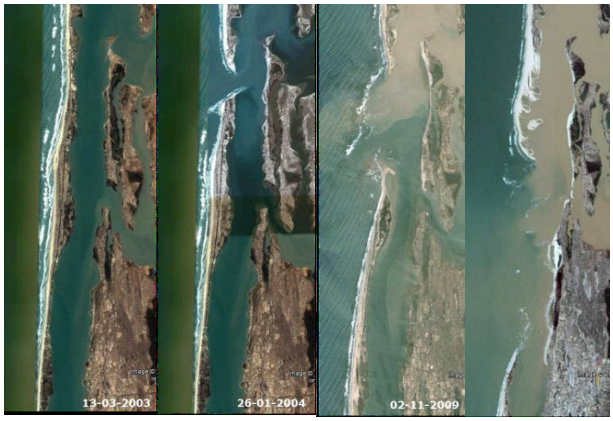

Figure 2 - The Langue de Barbarie sand spit in Senegal just before, and the years following the creation of an artificial breach in 2003 (Source: Google Earth).

METHODS

During the project, in-depth technical analyses were integrated with social, economic, financial, and environmental analyses. To understand the natural system in detail, at the start of the project extensive measurement campaigns were realized. High-resolution bathymetry and topography were acquired, together with information on physical processes such as water level variations, currents, waves, and salinity levels in the river. In addition, a field campaign was dedicated to the search of potential sand sources for nourishments. Furthermore, historic satellite images were analyzed (example in Figure 3).

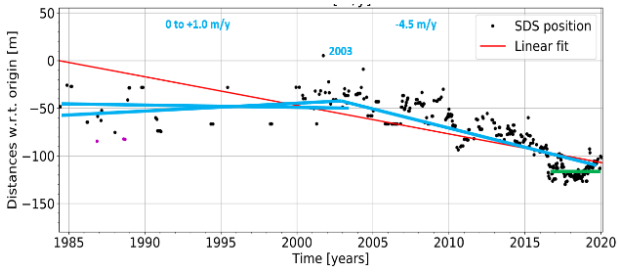

Figure 3 - Change in coastline position in front of the city Saint-Louis extracted from historic satellite images (Report 2; Egis-Deltares, 2020).

Various numerical (morpho)dynamic models (Infoworks, SWAN, Delft3D, Delft3D-FM, ShorelineS, Unibest-CL+, XBeach) of river- and coastal dynamics were developed and calibrated with the newly acquired field data, to evaluate various scenario's and help in the preparation of an integrated intervention plan.

MANAGEMENT STRATEGY LOWER-RIVER DELTA

Based on detailed system analyses using field data and exhaustive scenario analyses using numerical modelling in the PROGEP study a management strategy is retained. It is recommended to maintain the natural functioning of the lower delta, while attenuating the negative impact of the southward migrating river mouth. To avoid inundation of Saint-Louis after horizon 2050, whenever a peak river discharge (> 1/10-year return period) is measured upstream at the hydrological station of Bakel, an artificial breach should be created through the sand-spit a few kilometers south of the town of Degounaye (23 km south of Saint-Louis). This ensures protection against flooding of Saint-Louis up to a 100-year flood level by the year 2100, without large-scale negative impacts. In addition, a package of urgent "no-regret" protection measures is recommended: 1) reinforcement and heightening of the river dikes around Saint-Louis to at least 2mIGN and 2) reinforcement of the Langue de Barbarie sand spit to avoid natural breaches. Furthermore, 3) placement of localized sand nourishments to counteract erosion at the Gandiolais villages potentially exposed by the migration of the river mouth, 4) creation of a new bird island nature reserve, 5) extension of the Gandiolais irrigation channel and 6) ensuring safe navigation through the river mouth for fishermen by regular update of navigational buoy locations, safety equipment and trainings.

MANAGEMENT STRATEGY WATERFRONT

During the ongoing SERRP project, that mainly focusses on the recurrent coastal erosion at the waterfront of the city, various protection measures were evaluated, including offshore breakwaters, groins schemes, nourishments, crest elevation of the recently constructed emergency dike (PPCS project) etc.

To reduce the erosion risk, and to ensure the stability of the emergency dike in the short term, the placement of a large nourishment of about 2.5 million m^3 is recommended as soon as possible. For the next three decades, the positive effect of this massive nourishment combined with the effect of the Grand Tortue project (LNG mooring and transfer platform constructed off Saint-Louis) will contribute to stabilize and may even increase the width of the beach in front of most of the urbanized area. Detailed investigations on potential sand deposits for the nourishment were realized.

The zone south of the city is predicted to experience erosion after 2050 and could be further protected either by additional nourishment or by the implementation of one or more transverse groins. In any case, these transverse groins will have to be (very) small, and be combined with an initial nourishment, so as not to exacerbate the erosion and breach risk induced by the Grand Tortue gas project to the south of the urbanized area.

To mitigate the impact of sea-level rise on the increased risk of marine flooding, it is recommended at horizon 2050 to reinforce the dike using the latest climate change projections. The Grand Tortue offshore breakwater is predicted to affect the coastline in and around Saint-Louis. Whereas this offshore structure will affect the coastline directly in front of the city in a positive way, and gradual beach accretion is predicted (Figure 4), further south of the urbanized area erosion is foreseen, with in time, the possible formation of a breach through the sand spit. The formation of a new breach will severely impact the hinter lying Gandiolais region. Additional monitoring and measures will therefore be needed in this area to reduce the risk of breaching due to this erosion (also on the future part of the Langue de Barbarie, at the current position of the river mouth).

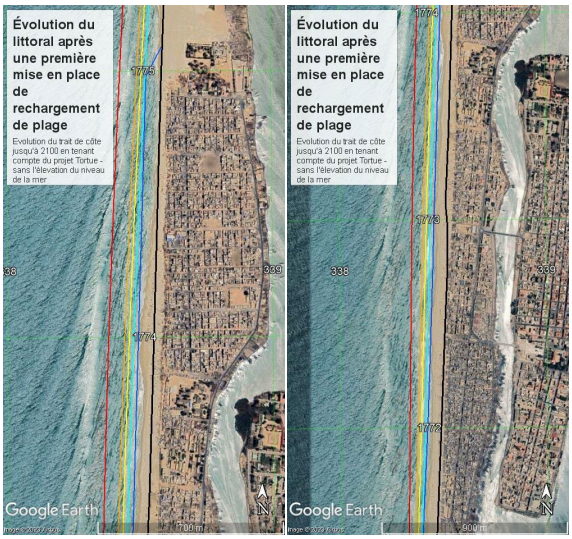

Figure 4 - Predicted accretion using UNIBEST-CL+ directly in front of Saint Louis between 2020 and 2100, with nourishment, including the (locally positive) effect of the Grand Tortue offshore platform (Report 10; Egis-Deltares, 2023).