MAPPING OF FLOOD COASTAL AREA IN GRAND-BASSAM (IVORY COAST)

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Abstract-- In order to ensure efficient management of the Ivorian coastline and specifically Grand-Bassam area which was hit sometimes by storm episodes, topo-bathymetric surveys on the beach with a DGPS were carried out between November 12, 2015 and February 27, 2016. Those measures designed to assess the level of vulnerability coast helped to develop Digital Elevation Models by the interpolation method of the natural neighborhood and Triangulated Irregular Network of ARCGIS 10.2.2 software and have enabled a sediment budget on the beach. A decrease of altitudes of -0.6 m on the upper and lower estuary translates a volume of eroded sediments of -2469.58 m^3. The remaining beach is fattened with sedimentary volumes of + 38242.92 m^3 for gains of altitudes ranging from + 1.9 m to 0.03 m. Spatial queries helped identify and calculate the potential flood areas by crossing topographic data to sea-level rise. Tides data have been acquired on Hydrography and Oceanography Marine Service (SHOM) site and adjusted by the generalised extreme value method. Sea-level rise is 15.7 mm to estimate 15 629.52 m^2 of flood surfaces for a total area of 76818.98 m^2 sediments, which represents 24.34% of the sediments surface of the beach.

Keywords - Digital Elevation Model, DGPS, extremes tides, sea-level rise, SHOM

INTRODUCTION

Sea level rise is one of the main consequences of global warming, which threatens many low-lying coastal areas and small, densely populated islands. In these areas, sea-level rise is amplified by stresses due to natural phenomena (eg, soil subsidence in the delta zones induced by sediment load, vertical soil movements due to tectonics, Volcanism and post-glacial rebound, etc.) and / or human activities (eg, subsidence of soil due to pumping of groundwater and / or oil extraction, urbanization, etc.). In addition, tide gauge observations for the last century and sea-level measurements from space-based altimetry missions in recent decades have shown that sea-level rise is far from being On the contrary, showed strong regional variability (Becker et al. [1]). In Ivory Coast the consequences are numerous for every rise in the level of the ocean: loss of biological diversity, disturbance of river hydrological regimes, disruption of economic activities, etc.

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1. LOCATION OF STUDY AREA

Between longitudes 3°32'W and 3°38'W and latitudes 5°10' N and 5°12'N, Grand-Bassam coast is located in the eastern extension of the shore of Port Bouet. It is located west from Comoé river mouth, to the east by the Awankro village, to the south by the Atlantic Ocean and on to north by the Grand-Bassam road. The study area is a tourist hub hosted by many resorts, some of which are also located in Coconut village and Awankro areas. Fishing activities are strongly practiced here (fig.1).

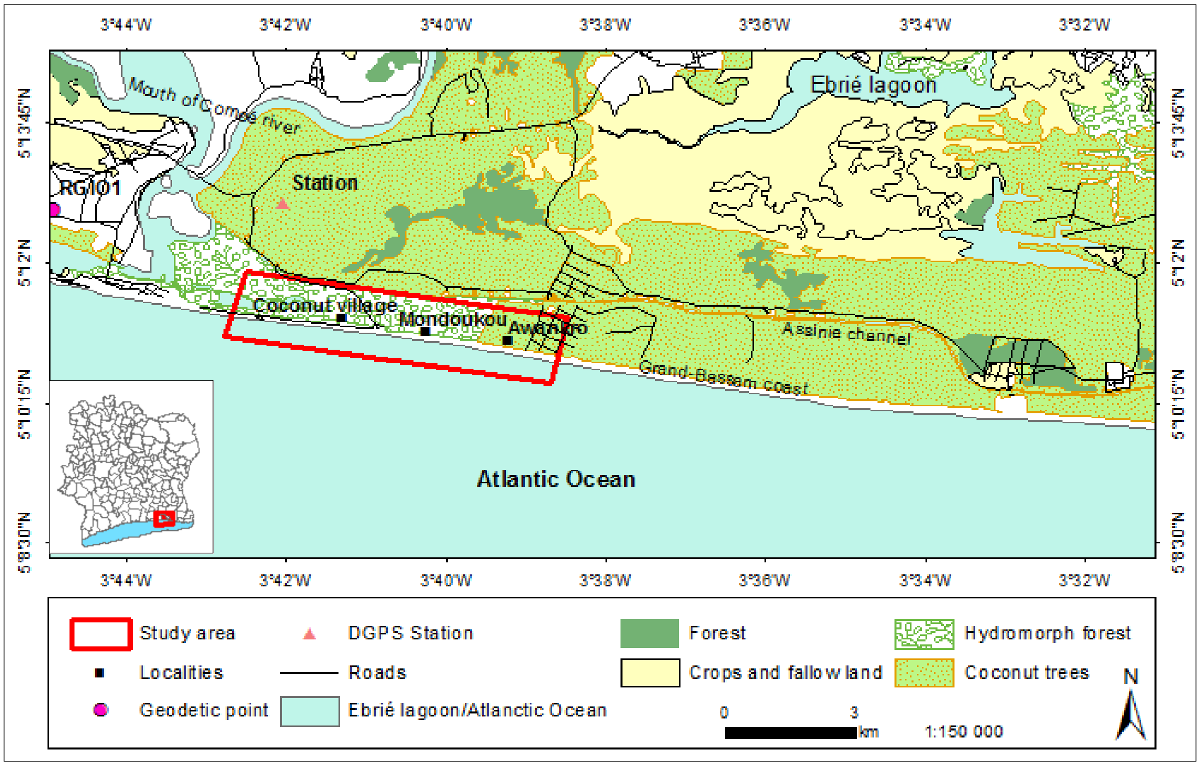

Fig1.Location of study area

2. MATERIAL AND METHODS

The morpho-sedimentary evolution of the Grand Bassam coast consisted of topo-bathymetric surveys on the beach from 2015 to 2016 using a Differential GPS (DGPS) of 0.5 mm accuracy. The collected data were subjected to spatial interpolation processing in the ARCGIS 10.2.2 software for Digital Elevation and Surface Models calculation of the beach. The natural neighborhood interpolation method was chosen because of the geographic boundaries of the interpolated raster that coincide with the DGPS points spatialization. The calculated Digital Elevation Model is used to create the Triangulated Irregular Network (TIN). The coast altitudinal and sedimentary variation are obtained by subtracting the Digital Elevation Model and TIN using the commands "Raster math" and "Surface difference" of ARCGIS software. As for observed tidal data, they were acquired on the SHOM site (Hydrographic and Marine Oceanology Service), http://www.shom.fr/les-services-en ligne/predictions-de-maree/presentation/ for 2009-2016 period. Only maximum peak heights were used to statistically estimate extreme tide heights using software R. Adjustments to observed and predicted tide heights were made within a 95% confidence interval using the generalized extreme values method. The flood coastal areas are obtained by topographic data with extreme tide heights comparing.

3. RESULTS AND DISCUSSION

3.1 Morpho-sedimentary variation of Grand-Bassam coast between November 2015 and February 2016

These altitudes reach between 27.145 m and 27.62 m on most of the upper estuary in 2015 (fig.2A), reaching heights of up to 28.748 m, which remain constant on the upper estuary in 2016 (fig.2B). The lower estuary, the initial altitudes are 25.319 m and remain constant in order to decrease towards the Awankro area. The increase in elevations on the upper estuary mainly results in very low slopes of the order of 5% on the beach. The morphological evolution then shows gains of beach altitudes between +0.3 m and +2.1 m and a loss of -0.6 m causing quantities of eroded sediments on the upper estuary (fig.2C). The eroded volumes are located on the whole of the upper estuary. The accumulated quantities are spread over almost the entire mean estuary and oscillate around 1.9 m. Gains between +0.03 m and +1.9 m are spread over most of the beach. Morpho-sedimentary changes during this calm weather season could also be explained by currents in the opposite direction that would cause the erosion of the upper estuary of this coastal zone. The eroded quantities are estimated about -2469.58 m^3. The accumulated sedimentary volume is approximately +38242.92 m^3, resulting in a sedimentary evolution of +35773.34 m^3 during this period (fig.2D).

ISSN 2229-5518

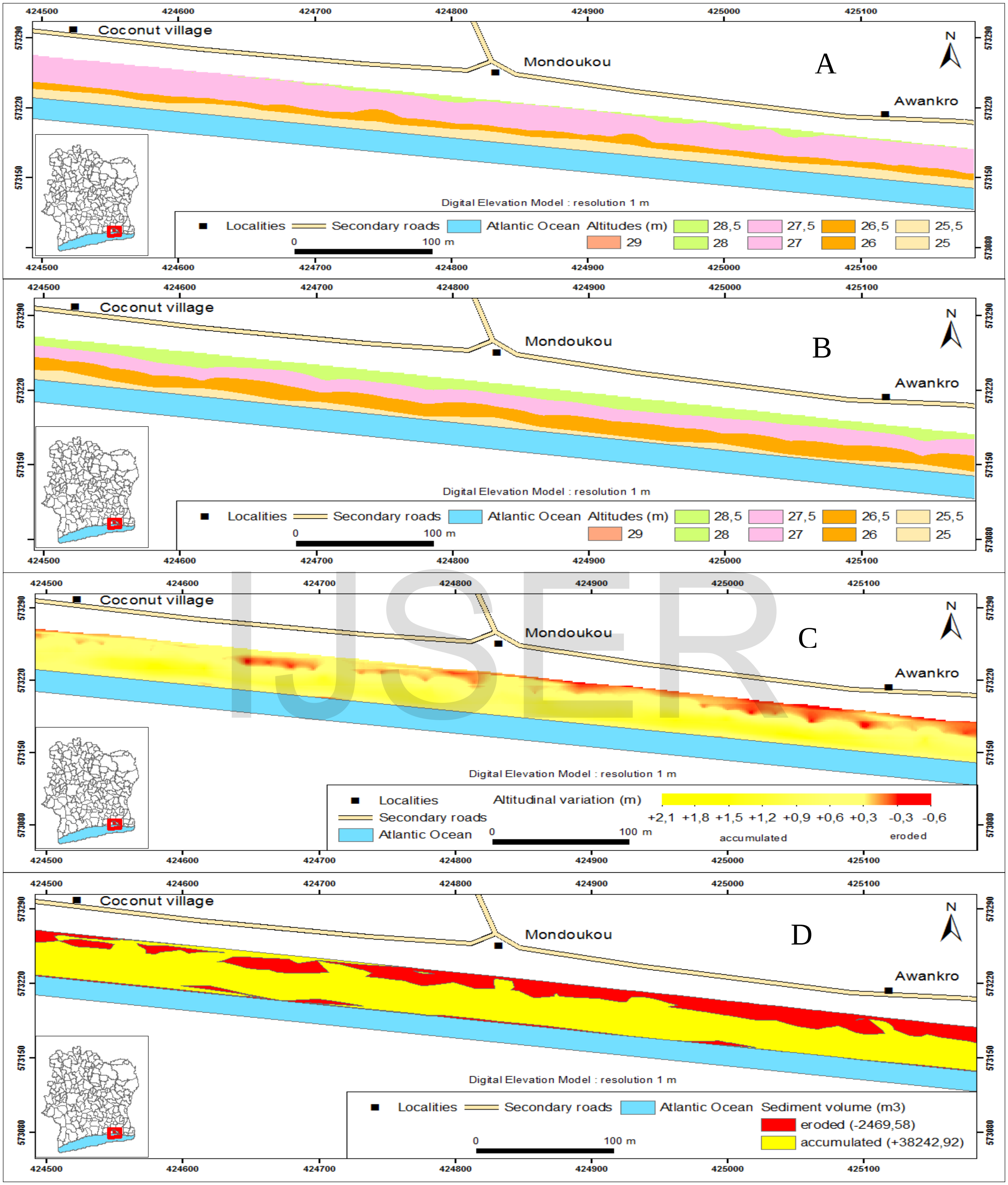

Fig2. Morpho-sedimentary variation on Grand-Bassam coast

3.2 Extreme tide heights

Extreme tide heights increase with return periods. They vary between 1.01 m and 1.17 m. Adjustments were observed at tide heights between 0.8 and 1.2 m and a margin of error about 10 cm (fig.3A). Sea-level rise, which is almost zero between 0.4 and 0.8 m of observed heights, appears essentially at a high density of observed data, that is to say between 0.8 and 1.2 m. It is around 15.7 mm with a standard deviation σ = 0.079 (fig. 3B).

3.3 Coastal floodplains in Grand-Bassam

On the Grand Bassam coasts, the return periods made it possible to estimate flood areas about 15,629.52 m² for a total area of sediments of 76818.98 m², ie 24.34% of flooded areas on the beach (fig.3C). The estimates are the same for the different return periods.

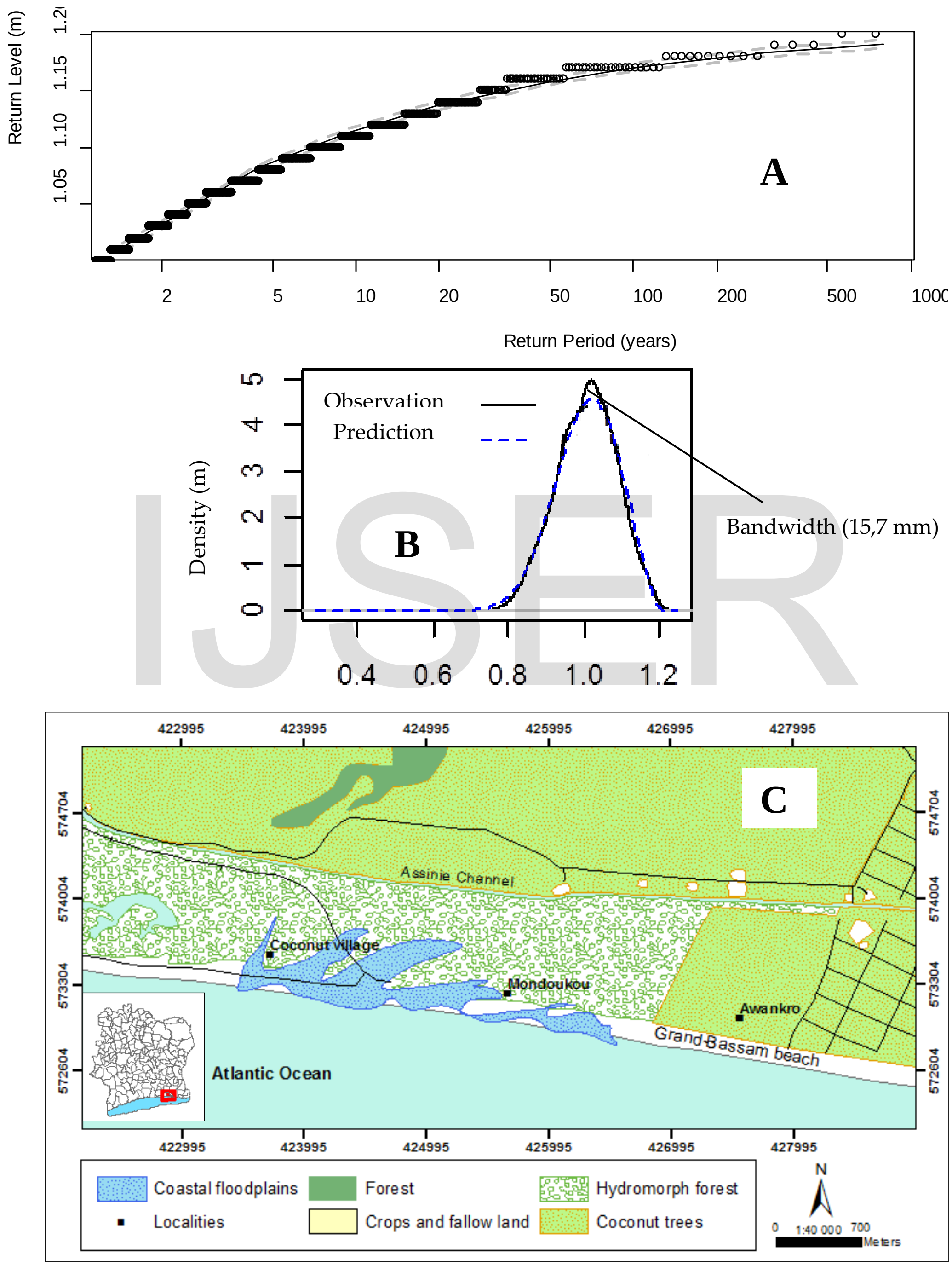

Fig3. Extreme tide height (A), sea-level rise (B), coastal floodplains (C) in Grand-Bassam

3.4 Discussion

Flood zones were identified from observed tidal heights to which sea-level rise was added. The percentage of floodable areas is around 24.34% and remains the same for all return periods with a much larger area of fine sands. These results confirm those of [2] which described the equilibrium of this beach outside the effects of storms. Observed tidal data do not come from the tide gauge "Appontement", located at the west pier of the Vridi Canal. These data are SHOM predicted previous data that we have blended to make our predictions. They can be source of error and a limitation of this study. The calculated sea-level rise remains very low (15.7 mm) for the short time series of our study (2009-2016), ie 1.96 mm / year. According to Woodworth et al. [3], changes in mean sea level rise are virtually similar across the globe if long-term trends in water levels are taken into account. For more than a century, tide gauges have shown an increase of 1.8 mm / year, and for 22 years, this increase tends to accelerate to 3.3 mm / year by satellite observations [4]. These estimates are in line with those of our marine environment, which has a low tidal range (around 0.4 m), except for specific areas. The dependence between the tide and the sea-level rise is highlighted here. [5] estimates that the dependence between the sea-level rise and the tide is an amplitude and non-seasonal dependence. Therefore, high resolution hydrodynamic numerical models should be undertaken to assess the contribution of wave set-up in a context where storms have already occurred and caused marine submersion.

CONCLUSION

The morpho-sedimentary monitoring of the Grand Bassam coast using precision tools (DGPS) helped identify eroded or fattening areas. It is essentially an altitudinal loss of -0.6 m for -2469.58 m³ of eroded sediments on the upper estuary. These quantities tend to be balanced with a strong fattening of the lower estuary in front of the sea level rise. Potentially floodable areas caused by sea-level rise remain virtually constant regardless of the associated return periods. The morphological equilibrium of this beach could be the reason.

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