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HYDRO-SEDIMENTARY OPERATION AND IMPACTS ON THE ESTUARY ENVIRONMENTAL OF COMOÉ RIVER AT GRAND-BASSAM (CÔTE D'IVOIRE)

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Abstract
The study led to the estuary of the Comoé River presents the pétro-sedimentary characterization of the sandy coastline. Ten (10) samples of sand samples have been collected to make granulometric and morphological study of the estuary of the Comoé River. The study has showed that the granulometry of sand fluctuate between fine and coarse sand. These sands are settled in a fluvial environment. The examination of the morphology shows that between 2005 and 2007 years, the depth of the Comoé River underwent, on the whole, some important modifications, which are characterized either erosions (negative variations of thickness), or sedimentation (positive variations of thickness).

Keywords: Comoé, estuary, granulometry, morphology, sediments

1. INTRODUCTION

The effects of climate change, which are at the origin of several disasters in the world are increasingly felt in Côte d'Ivoire. Indeed, there has been in recent years important phenomena of floods, drought and coastal erosion (Masselink, Short, 1993). Hydro rainfall fluctuations taking place, have a negative impact on both the economy (farming, fishing, etc..) and safety populations (flood). With regard to flooding, coastal areas are most at risk because they are the neighborhoods of the mouths of major rivers, which are generally lowland areas where runoff is slow (Bouanani, 2004). When floods occur in coastal cities, there is a lot of damage and loss of life because coastal areas are densely populated due to the natural assets they hold (Romanescu, 2013a,b). In Côte d'Ivoire, coastal erosion is increasingly a major concern for all humanity, especially for countries with a coastline. Indeed, under the influence of tides, longshore currents (longshore drift), river flow and lagoon morphology of the coastline is constantly altered causing erosion and active daily felt by residents (Wognin, 2004). Erosion pushed back the coastline and destroys habitats and plantations forcing some people to move. On the coast of Côte d'Ivoire, the magnitude of erosion is severe experienced in all major coastal cities (Abé, 1995; Abé et al., 1996; Aka, 1991; Yacé, 1987). This phenomenon has caused the displacement of the Town of Grand Lahou on the north shore of lagoons inland in the 1970s (Wognin, 2004). A Grand Bassam, the magnitude of the problems hydrosédymentaires resulting in the closure of the mouth, the destruction of homes, the proliféeration of VAE (Aquatic Plants Pervasive) and floods (Adopo, 2009). The deposition conditions of fluvial sedimentary formations in the overall dynamism of the mouths of the Ivorian coastline explain these impacts (Adopo, 2009). In order to better understand the geological history of the river estuary Comoé, this study's main objective is the determination of the conditions and environments of sedimentary deposits.

2. STUDY AREA AND METHODS

2.1. Study area

Sector Comoé River estuary is at the eastern end of the lagoon Ebrié. It is located between 5°12'and 5°14' north latitude and 3°42 'and 3°44' west longitude. This area is the largest estuary in the Ivorian coast (Koffi et al., 1991). It covers around the island Morin at North Bridge Moossou at the confluence of the river and lagoon Comoé Ebrié Bouet Island and the coastal strip in the south. It includes the arms of the river course Comoé north-east (Figure 1). The estuarine zone is fed by freshwater river that drains Comoé the hinterland and whose watershed covers an area of 78,000 km^2.

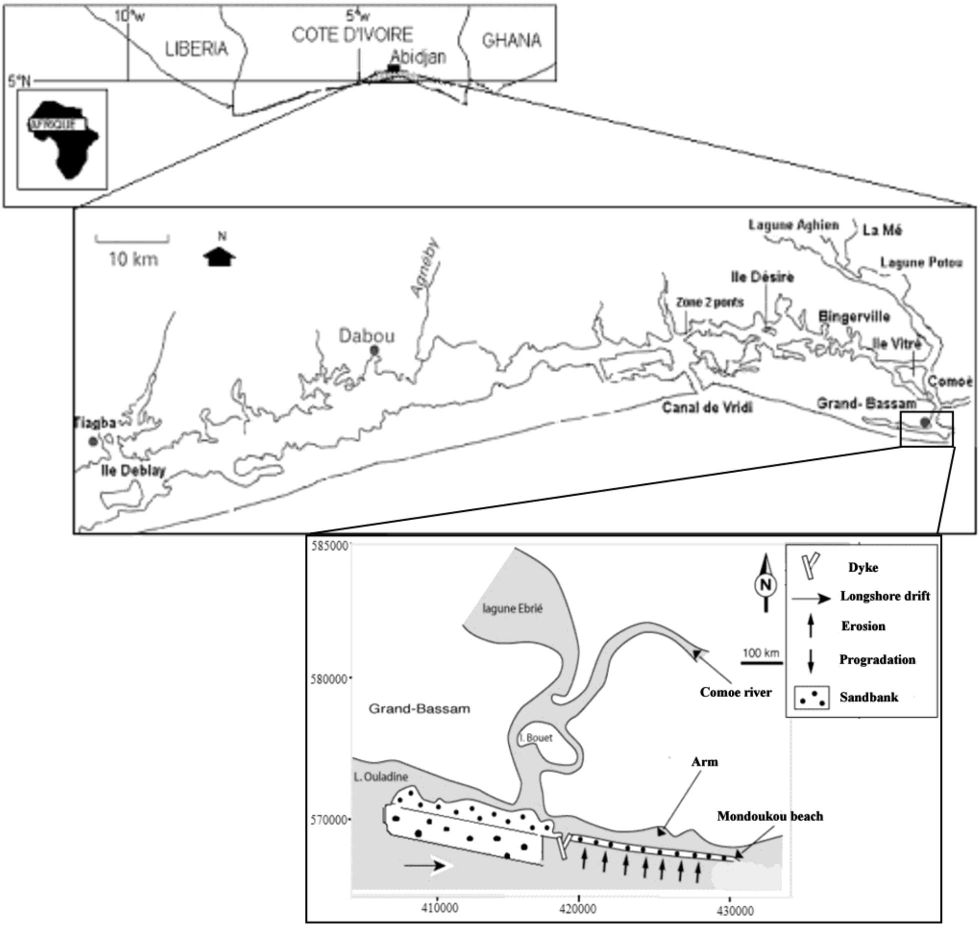

Figure 1 Location of estuary of Comoé River at Grand-bassam

2.2. Methods

To determine the particle size characteristics of the sands of the estuary of the river Comoé, ten (10) Sediment samples were collected using a Van Veen grab. These sediments have suffered dry sieve analysis according to the technique described by Saaidi (1991). The sands of the estuary were characterized through average size (Mz), the skwness (Sk) and the classification index (So), as determined using the methods of Folk (1974). The depositional environments were determined from charts and So-Md Md-Sk. Test Visher (1969) identified modes of sediment populations. The study of the morphology of the bottom of the estuary was conducted by bathymetric surveys, conducted using an echo sounder type Lowrance

LMS-160 model (Figure 2). Depths are obtained and the measurement between the position of the echo sounder transducer and water-sediment interface. The surveys were conducted with a frequency of 160 kHz which allows signals do not penetrate vases.

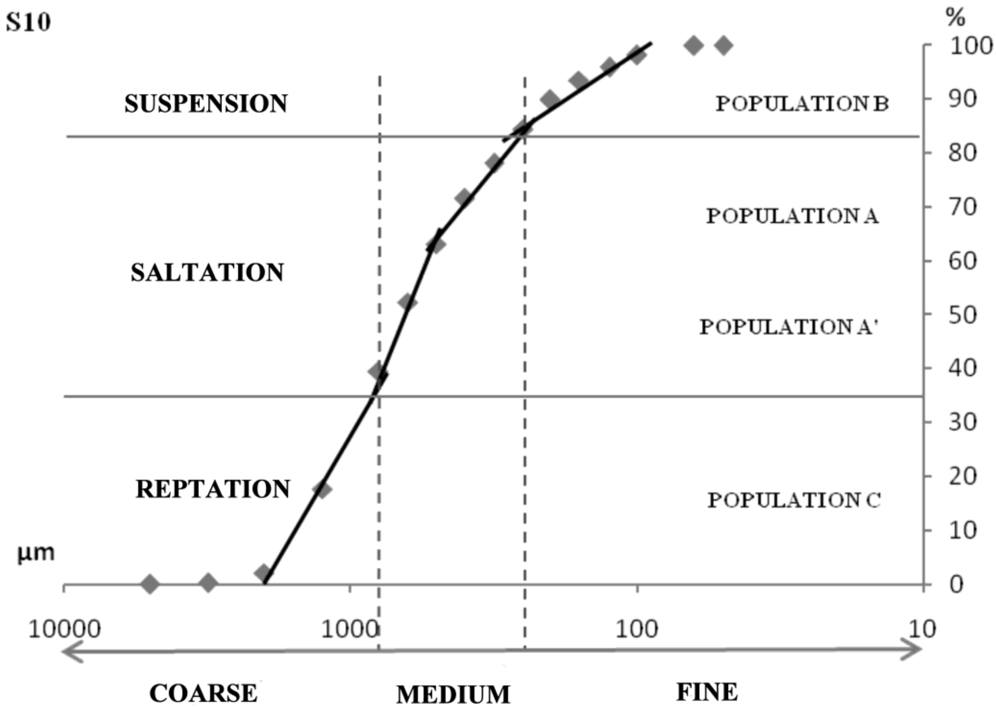

Figure 2 Visher test applied to estuary sediments of Comoé River

3. RESULTS

3.1. Particle size analysis of sands of the river estuary Comoé

The particle size of the sand content in the sediments reveals that the grains are very fine to coarse (Table I). The color is yellowish-brown sand to varying degrees. Sediments found in some plant debris and shell. For all sediments, sands resources are most abundant with an estimated 55%, followed by coarse sand with an estimated 25%, then fine sands with a rate of 15.00% and finally the very sands for representing 5% of the whole. Size coarse sediments shows that the level of the river estuary Comoé, energy sediment transport is low. So that the coarse elements have time to settle.

Table 1 Granulometric proportion samples of estuary of Comoé River

Sampling point		Description of sediments	Mz (µm)	Sk	So
Longitude	Latitude				
429326	580837	Coarse sand; yellow-red; moderate clasticity	765	0.66	0.95
429344	580485	Very fine sand; grey; moderate to low clasticity	115	0.82	0.23
425633	579726	Coarse sand; yellow-red; moderate clasticity	625	0.75	0.55
425630	579481	Coarse sand; grey; moderate to low clasticity	835	0.85	0.25
421475	577971	Medium sand; yellow-red to grey; moderate clasticity; shell detritus	482	0.68	0.45
421478	577750	Medium sand; grey; moderate to low clasticity	440	0.85	0.26
420640	577933	Medium sand; yellow-red to grey; moderate clasticity; shell detritus	412	0.76	0.50
419439	576380	Medium sand; yellow-red to grey; moderate clasticity; shell detritus	458	0.66	0.52
420092	576381	Medium sand; yellow-red to grey; moderate clasticity; shell detritus	459	0.78	0.55
420479	576374	Medium sand; yellow-red to grey; moderate clasticity; shell detritus	476	0.77	0.48
419385	574830	Fine sand; grey; moderate to low clasticity	158	0.86	0.30
419582	574846	Fine sand; grey; moderate to low clasticity	213	0.80	0.31
419877	574846	Fine sand; grey; moderate to low clasticity	420	0.82	0.28

3.2. Mode of sediment transport

Visher test (1969) identified three populations (A, B, C) of sediment transported differently (Figure 3):

- Transport by saltation has a particle size distribution in both populations A and A'. The dominant mode of sediment transport of sand saltation with a share of 61.15%. This population is composed of sand means (200 <Mz <500 microns). In the case of a two saltation populations A and A ', the segment A' shows a better ranking than the segment A. This result is the opposite of what happens in a beach type deposit, which suggests that the finer fraction resulting from fragmentation of a portion of the coarsest fraction during a short transit . It has to do with a fluvial transport;

-The second mode of transport is rolling with a percentage ranging 35%. This is the population for C and coarse sands;

-Population B, we transport suspension is estimated at 18.85% of the grains. Particles that undergo this transport mode are fine and very fine sands. Ultimately, the dominant mode of transport in the estuary of the saltation is Comoé.

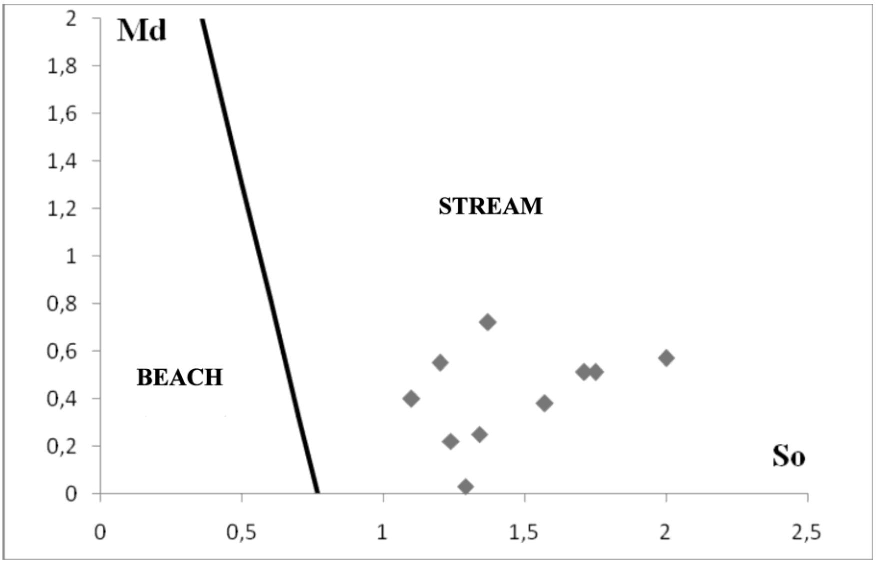

Figure 3 Md-So diagram

3.3. Environment sediment deposition

The dispersion of the whole (100%) of the grains is located directly above the regression line. The sands of the estuary of the field thus characterized Comoé river type (Figure 4). Following diagram Ski-Md, we note that the scatter is mainly (90%) in the field of inland dunes with a presence of some points in the coastal dunes. The study of discrimination of depositional environments indicates a fluvial depositional environment.

Sands characterize therefore the dune field type but specifically the continental fluvial domain.

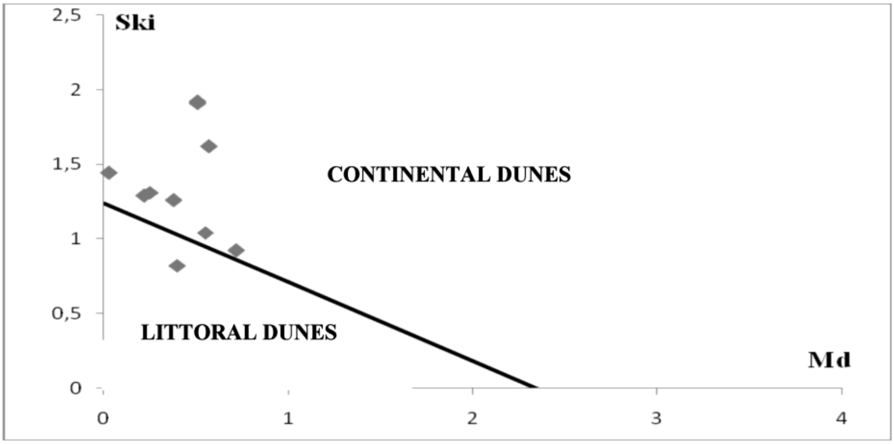

Figure 4 Ski-Md diagram

3.4. Evolution of the bottom of the river estuary Comoé

The rating 1.14 m of the water was used as a baseline to determine the changing trends in the bottom of the estuary. This value corresponds to the national standard. Figure 5 gives values indicative of variations in dimensions.

The overlay bathymetric maps made in 2005 and in 2007 helped to appreciate the evolution of the estuary's bottom. Throughout the estuary undergoes significant changes are characterized either by erosion (negative variations of mean thickness, -5 cm) or deposits (positive variations of average thickness, 15-20 cm) either stability or (0 cm) over the two years (2005-2007). These variations can reach -3 rating to 4m in places. However, there are areas where changes are not significant enough; variations odds vary between -2 and 0 m and 0-1 m (Table II).

Table 2 Varying the thickness of the deposit depending on the year

Sampling point	Deposit thickness 2005	Deposit thickness 2007	Thickness variation
1	13.30 m	13.50 m	20 cm
2	10.75 m	10.70 m	-5 cm
3	6.50 m	6.50 m	0 m
4	3.30 m	3.45 m	15 cm
5	9.10 m	9.6 m	-4 cm

6	10.40 m	10.38 m	-2 cm
7	7.30 m	7.27 m	-3 cm
8	2.15 m	2.14 m	-1 cm

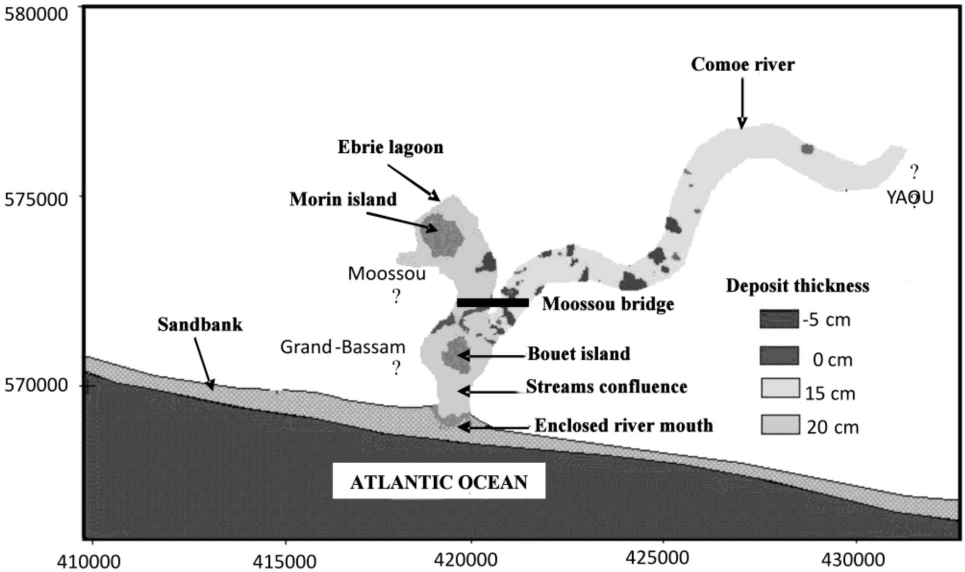

Figure 5 Depth variation of estuary of Comoé River between 2005 and 2007 years

4. Environmental Impact

Since opening in 1951 Vridi channel, water deficit was found at the mouth natural Comoé because about two thirds of its borrowing rate this outlet. The remaining 1/3 out at sea by the channel Vridi after traveling several kilometers Ebrie lagoon. This decrease in the volume of water greatly affects the speed of the currents in the estuary. This reduces the output of the river in the sea It oscillates between 0.05 m and 0.32 m/s (Abe et al., 1996). The significant reduction in river flows during low flow, particularly in recent decades due to the influence of climatic fluctuations, promotes sedimentation phenomena. The combination of fluvial deposits and longshore drift causes the rapid clogging of the mouth of Comoé. In addition, the mouth of Comoé is facing a problem of eutrophication is manifested by progressive and permanent settlement of the water by VAE. These make navigation difficult in the river estuary Comoé fields and thus reduce operating fishermen. This "meadow water" is composed of water hyacinth, fourgères water, water lettuce, lotus, etc. (Figure 6).

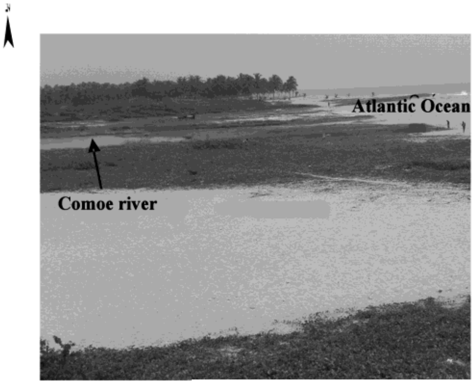

Figure 6 The coastal area of the Comoé River invaded by aquatic

It grows on sand activities such as pig farming. Which leads to unhealthy due to animal waste. In addition, this area serves as latrines for the local population. All these hydrodynamic forcings and anthropogenic make the river mouth Comoé object of this work, an environment that poses problems. The offshore no exception to the natural and anthropogenic forcings. Recent accentuate the problems of coastal erosion, urban pollution (garbage deposits on beaches) (Figure 7) etc.

Figure 7 House destruction at Bassam (a). Garbage deposit on the beach of Gran-Bassam

4. DISCUSSION

The coastline of Grand-Bassam is composed of quaternary sands (Tastet, 1972). The depositional environment of sediments is the area of beach and coastal dune field. The medium sand and coarse and met deposited by waves of medium and high energies (Abé, 1995; Affian, 2003).

These approaches differ from Lecolle (1971) which showed essentially muddy sediments (d <10 microns) lining the funds of the estuary. These vases cover of fine to very fine sand. Note that these vessels reported by Lecolle (1971) and relatively absent in our case could be swept away by the currents during major floods and reveal the fine to very fine sand. Also note that currently, the flows are strong enough to expel the sea turbid plume formed during the flood. In addition, the sands of the littoral drift contribute to filling the channels at the mouth (Affian, 2003).

The mode of sediment transport occurs in three types. Thus, the mode is obtained by rolling the opposite of what happens in a beach deposit type and suggests that the finer fraction resulting from fragmentation of a portion of the coarsest fraction during a short transportation. Therefore, it is of fluvial transport. Changes in the bed level of the river estuary Comoé were assessed from bathymetric maps of 2005 and 2007. These cards were used to quantify the volume of sediment deposited or eroded at the bottom of the river estuary Comoé between these two periods. Figure 5 shows the overall areas of fattening, areas of erosion and relatively stable areas of the estuary of the river Comoé. The sedimentary record of movements between 2005 and 2007 reveals a fattening 580,500 m^3 against an erosion of about 285,000 m^3 in the area bounded.

5. CONCLUSION

The sands of the river mouth Comoé are deposits of variable size. These sands are symmetrical size. In addition, they range from coarse to very fine. The grain size of the sand facies types are hyperbolic. This reflects deposition by settling after a decrease of wave energy. Saltation is the mode of transport of the sand deposits which environment type is of type fluvial river. The mouth of the river Comoé looks like an environment problem. Area accentuates the problems of coastal erosion and urban pollution. Eutrophication is manifested by progressive and permanent settlement of the water by invasive aquatic plants (VAE) making navigation difficult and reducing farm fields fishermen.

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