

Enrichment of the "Heart of Upwelling" Of Marine Ecosystem along the Coast of Cote D'ivoire (West Africa)

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ABSTRACT: The Ivorian marine environment is an environment favorable to upwelling, the development of large populations of pelagic species and belongs to the ecosystems in which most of the living marine resources. It is therefore subject to many human activities including fishing that brings important economic resources to fishermen. In order to understand its operation and determine the intensity and variation of heart of upwelling, an oceanographic survey was conducted. To do this the World Ocean Atlas database (WOA) was used in order to have temperature and phosphate data that once processed using software Ocean Data View (ODV) and Surfer allowed to have map and curves. Analysis of these maps shows variability in the intensity of phosphate enrichment as marine seasons as it is off or on the coast. The comparative study of temperature and phosphate trend curves shows a similarity between the movement of the phosphatocline and the thermocline during the season. However the different temperature fluctuations led to understand that the intensity of upwelling is not always linked to strong enrichment of the Ivorian marine ecosystem so therefore the heart of the upwelling.

KEYWORDS: Upwelling, Temperature, Phosphate, Cote d'Ivoire.

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I. INTRODUCTION

The coastal regions of the Gulf of Guinea is one of the marine ecosystems sheltering the most of the living marine resources. The Ivorian coastline in part is full of large amounts of resources Djagoua [1]. It is under the influence of seasonal upwelling Varlet [2], Morlière [3] and as the coastal upwelling ecosystems of the world, it is favorable to the development of populations of pelagic species which are important resources fish for Côte d'Ivoire. The importance of these fisheries resources has encouraged the development of fisheries in the Côte d'Ivoire. Indeed, the Côte d'Ivoire consumes about two hundred and fifty tons of fishery products. It produces about 130 000 tons of fish per year with 70% from coastal waters (lakes and seas) Abe [4].

The upwelling phenomenon is the sharp fall in sea surface temperature results in cold upwelling rich in phytoplankton. Specifically for fishermen, this ascent translates into a significant increase in the number of fish. The cold bottom water rich in nutrients (nitrates and phosphates) are the result of the decomposition of marine organisms. When brought to the surface, these nutrients feed phytoplankton, which also uses the dissolved carbon dioxide for photosynthesis. That is why upwelling causes a significant phytoplankton production in comparison with other areas of the ocean Djagoua[1]. Because phytoplankton is the basic food of many marine animals and these effects spread through the food chain.

We note that the upwelling phenomenon is unstable and monitoring is crucial to give the role it plays in the conduct of the food chain. To understand the Ivorian marine environment variability including the upwelling phenomenon, it is important to conduct this study. This study therefore determines the enrichment of the marine ecosystem along the Ivorian coastline while highlighting the intensity and variation of the heart of upwelling through the use of software Ocean Data View (ODV).

The figure 1 shows the area studied, the gulf of Côte d'Ivoire, a part of the large marine ecosystem of the Gulf of Guinea, which stretches from Guinea Bissau to Cape Lopez in Gabon Djagoua [1]. The continental shelf of this zone is located between 4° and 5°30' Nord latitude and 3°0'0" and 7°30' West longitude with a length of 566 km.

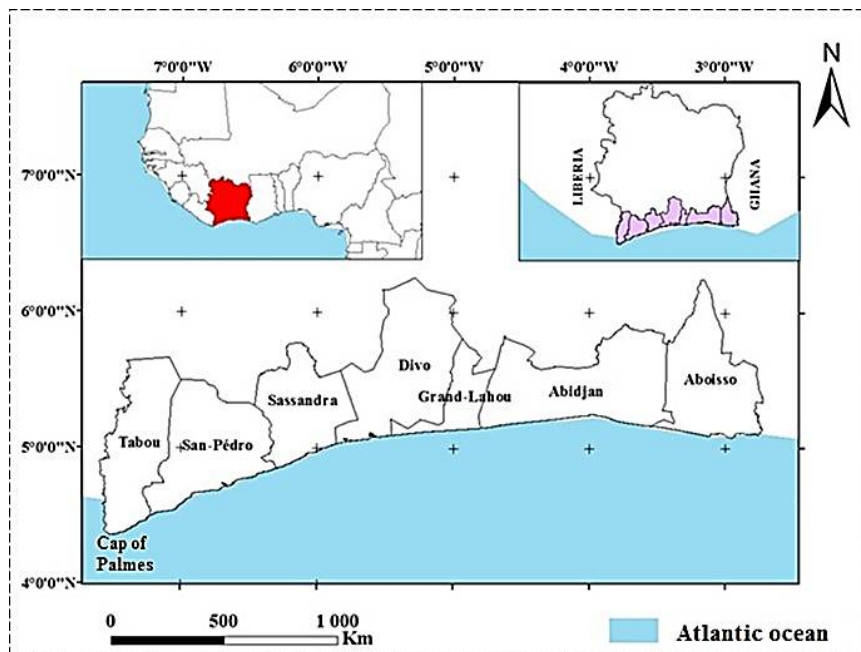


Fig 1: presentation of the study area.

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II. RELATED WORK

Côte d'Ivoire has a coastline of about 566 km. This coastline plays a vital role in the daily life of the people who are engaged in several activities, including fishing. The fishery provides important fisheries and financial resources to the people. Ivory Coast produces about 130000 tons of fish per year, 70% of which come from coastal waters (lagoons and sea) Abe [4]. The proper functioning of this activity depends closely on the phenomenon of upwelling, which is the sudden drop in sea surface temperature resulting in a rise of cold water which is rich in phytoplankton. Our study was carried out to understand the functioning of the Côte d'Ivoire marine environment. It took place as follows:

- 1- Use of temperature and phosphate data from the World WOA 2009 data base. These data were acquired over 12 months to allow monthly and seasonal monitoring of enrichment along the coast of Côte d'Ivoire
- 2- Using the ODV software for processing, analyzing and extracting WOA 2009 data
- 3- Use of the Surfer software for the realization of annual graphs of phosphate and temperature.

III. METHODOLOGY PROPOSED

II.1 DATA

In this study, we used the global database called the Ocean World Ocean Atlas (WOA). World Ocean Atlas is a data product of Ocean Climate Laboratory of the National Oceanographic Data Center. It is a set of in situ climate data from ocean parameters (temperature, nitrite, nitrate, oxygen, phosphate...). They are available and free on http://www.nodc.noaa.gov/OC5/WOA09/pr_woa09.html. The data used in this study are the temperature ($^{\circ}\text{C}$) and phosphate ($\mu\text{mol.l}^{-1}$) from WOA09 acquired over a 12-month period to allow monthly and seasonal monitoring of enrichment along the littoral.

To follow the heart of upwelling and this enrichment, the zones of the high gradient of phosphate (phosphatocline) and the low gradient of temperature (thermocline) are researched. According to Bakun [5] and Bakun [6], the phosphatocline and the thermocline are the zones with, respectively, a high vertical gradient of the phosphate, i.e. where the concentration of phosphate grows rapidly with depth, materialized by a concentration of $0.3 \mu\text{mol.l}^{-1}$ and the low vertical gradient of the temperature characterized by its diminution from the surface to deep. This line is materialized by 25°C . Below the limit of $0.3 \mu\text{mol.l}^{-1}$, we have a low phosphate enrichment and when this limit is on the surface (close to the coast) we have a high enrichment. On the other hand, below the limit of 25°C , we have a high temperature (low intensity of upwelling) and under the limit the upwelling is more intense.

II.2 METHODOLOGICAL APPROACH

For the determination of these zones, the Ocean Data View (ODV) software is used. Indeed, the figure 2 indicates that it is permitted to visualize data at different depths along the path of a boat and locate the different positions of the phosphatocline and the thermocline.

Finally, the Surfer software helped to establish the phosphatocline and thermocline spatio-temporal maps using XYZ in three columns, corresponding respectively to the latitudes, months and depth of phosphatocline and thermocline.

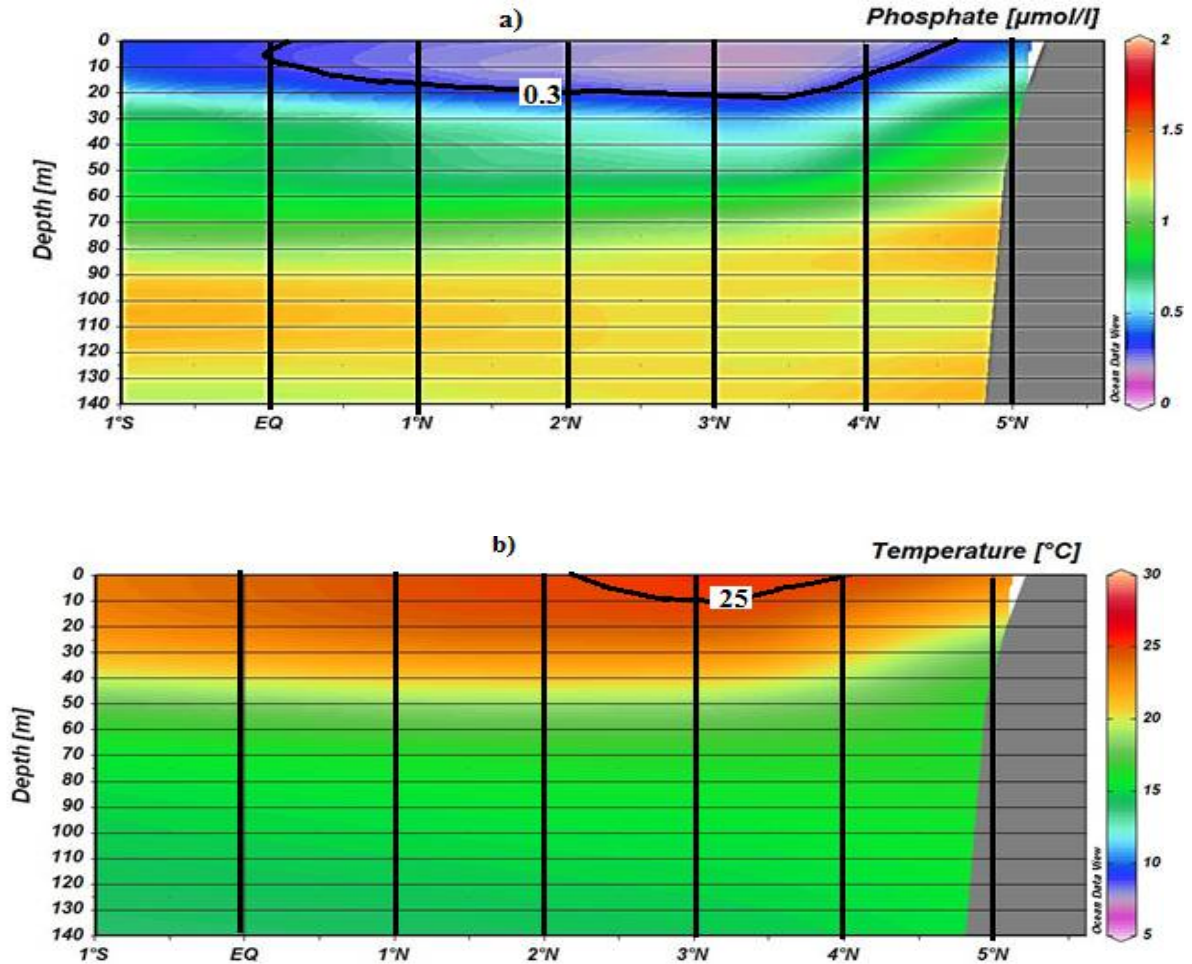


Fig. 2. Phosphate enrichment along the shoreline (a) and Ocean temperature at the Ivorian coastline (b) in ODV software (august data)

IV. EXPERIMENTAL RESULTS

The study of upwelling intensity of the Ivorian marine ecosystem has given results presented on the Fig3. According to the phosphatocline graph (Fig3a), we have a period when water bodies are poor of nutrients (phosphate) at the sea surface from October to June. The line $0.3\mu\text{mol.l}^{-1}$ is located between depths 25 to 60 m. These are periods which are characterized by the thermocline situated between 10 and 60m (Fig3b).

This figure shows that, the distribution of the value $0.3\mu\text{mol.l}^{-1}$ shows a rise of this line from July to return to mid-September. As for the isovalue 25°C , characterizing the thermocline, it begins its ascent towards the surface at the end of June and redescend in October.

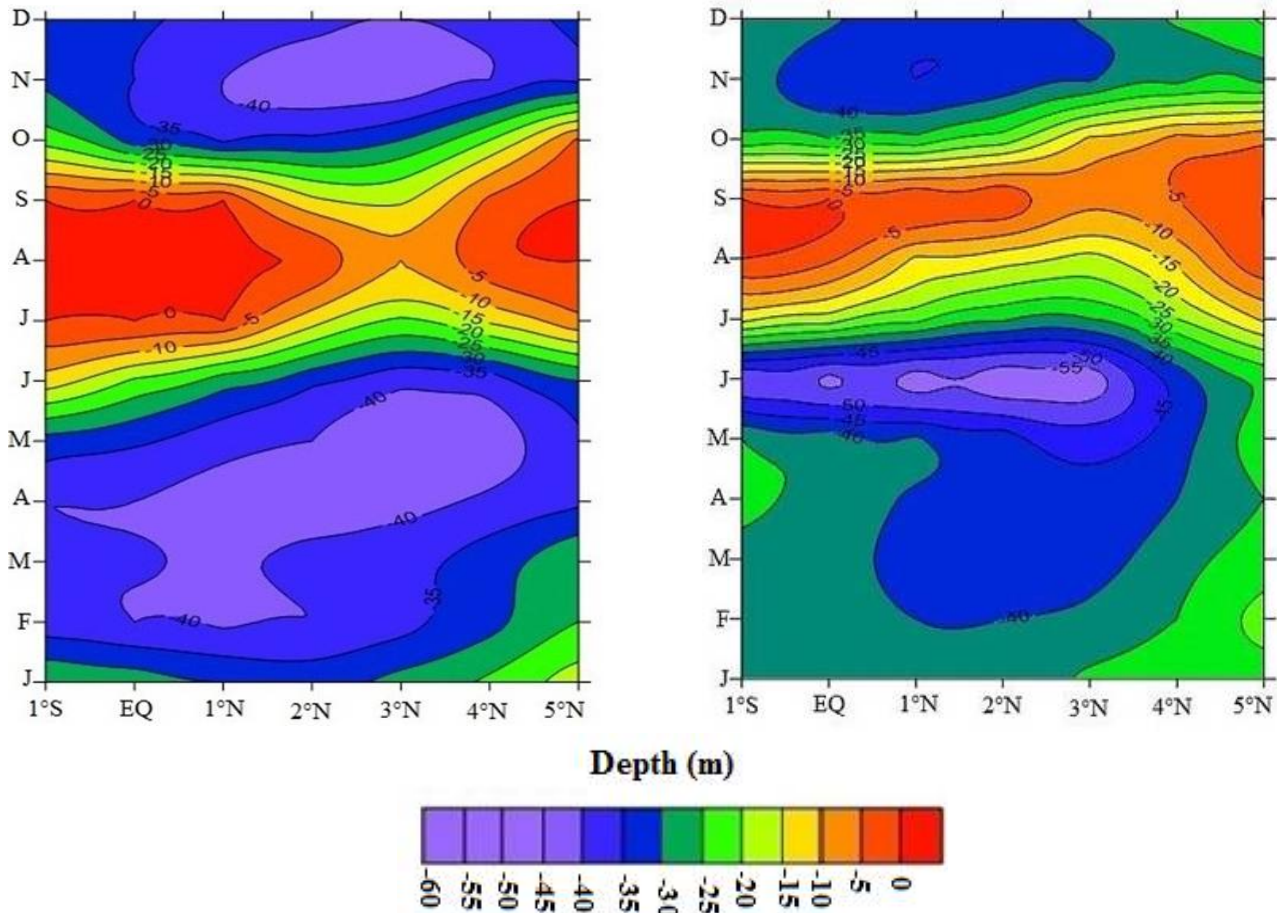


Fig. 3. Evolution of phosphatocline during the year on the coast of Ivory Coast (A) and Variation of the depth of the thermocline during the year at the level of the Ivorian littoral (B)

V. DISCUSSION

This corresponds to an intensification of upwelling and a high concentration of nutrients (Djagoua et al. [7]). The Fig 3 shows a nearly similar distribution between the temperature and the phosphorus concentration in the Ivorian marine environment. That indicates that the thermocline greatly influences the distribution of the concentration of phosphate Dugdale [8]; Morlière and Rebert [9]. Thus, a low temperature leads to an increase of the phosphorus concentration. In warm periods, the thermocline is a barrier to the rise of phosphatocline and also minerals. Also during this period, the absence of upward movements favors the formation of a thermocline above which the waters are poor in nutrient salts in general but especially in phosphate.

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VI. CONCLUSION

This study shows that the waters of the Ivorian marine environment have a high nutrient enrichment especially during the months of July, August and September where the phosphatocline is close to the surface. This study revealed that the heart of the Ivorian upwelling is in August and is associated to the intensity of upwelling observed in September.

This study is all the more important because biogeochemical studies in Ivory Coast marine waters are rare. Therefore, a study on this aspect is urgently needed to understand how this ecosystem works for fisheries management. For this, the "World Ocean Atlas" data are an alternative in the text region.

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