

FISHERIES AND OCEANS RESEARCH CENTER OF BENIN

INFLUENCES OF CLIMATIC VARIABILITY ON COASTAL OCEANOGRAPHY OF BENIN

BY

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Abstract

Monthly average of air temperature at Cotonou Cadjehoun station (06° N X 002°23 E) over 10 years (from 1975 to 1984), as well as fifteen-day and monthly averages of Ocean surface temperatures in Cotonou for the same period have been studied and analyzed. The rains (precipitations) heights were analyzed and correlated with air and sea surface temperatures. On the basis of data collected, variation of sea water temperatures and salinities according to the depths had also been studied. It's a question of identifying thermocline zones and to understand variations in depth of the upwelling phenomenon during a year. An attempt to correlation of the monthly production of pelagic species (*Sardinella spp.*), indicator of the phenomenon, has enabled to see the composite correlation with the air temperature.

Introduction

Republic of Benin is located at the east part of the Gulf of Guinea and has a coastline of approximately 125 km opened on the Atlantic Ocean

The majority of the descriptive studies on the Benin Coastal Oceanography relate as well as the Gulf of Guinea Countries.

However, since 1985 and 1986 systematic oceanographic surveys were undertaken by our Centre, in cooperation with the French Research Organisation, ORSTOM in the Benin seawater. From 1990 to 1997, other fisheries and oceanographic surveys have been realized with the Canadian Agency (CIDA) support.

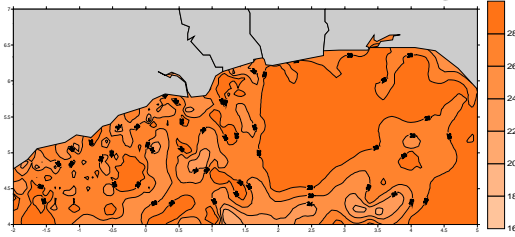
Many others very important regional surveys (Nansen Program and FAO : 1999, 2000 and 2002)

The data used

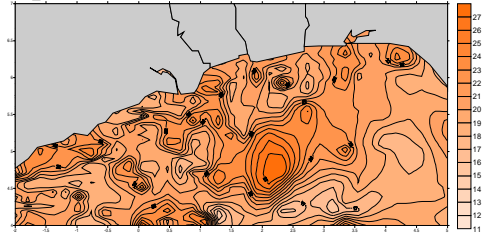
Several types of data were used for the study : air temperature, wind velocity; rainfall ; height data over 10 years (collected at the Cotonou station from to 1984)

- Sea Surface Temperature for the same period ;
- Sea water temperature and salinity variation according to the depth
- Monthly data on the annual pelagic species (*sardinella Spp*) production .

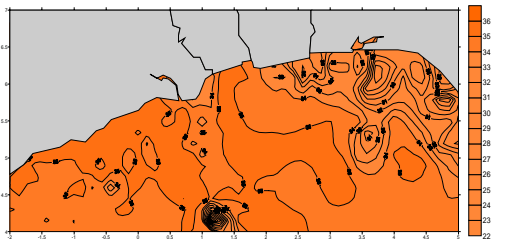
Sea Parameters Average at different depth, (Period 1961-1990)



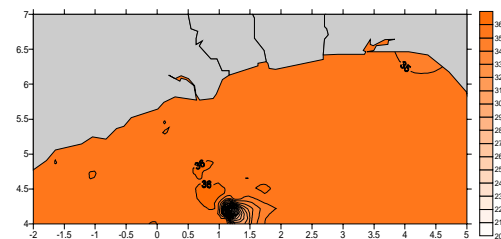
Temperature 0m



Temperature 50m

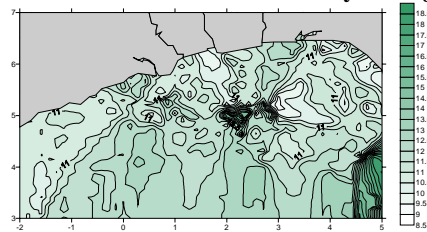


Salinity 0m

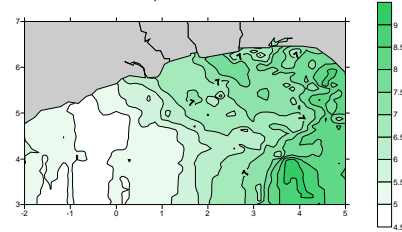


Salinity 50m

Daily average of Chlorophyll Concentration, in 2002



Hot Hydrological Season – February



Cold Hydrological Season - August

Table 1: Average sea surface temperature in Cotonou per fifteen-days
1- First fifteen 2- Second fifteen

Month	January		February		March		April		May		June		July		August		Sept.		Oct.		Nov.		Dec.	
	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
1975	27	27	28	28	28	29	29	29	29	29	29	27	27	25	24	24	23	25	26	28	28	28	28	27
1976	27	27	29	29	29	29	29	29	29	28	28	26	24	24	24	24	24	25	26	26	27	27	27	27
1977	27	28	28	28	28	29	29	29	29	29	27	27	26	26	24	25	25	26	26	27	28	28	28	26
1978	27	28	28	28	29	29	29	29	29	29	28	27	24	26	25	25	25	26	27	27	28	29	28	28
1979	28	29	28	28	29	28	30	30	29	29	29	28	26	26	26	26	27	27	28	29	29	29	29	29
1980	28	29	29	30	29	29	30	30	30	29	29	27	27	25	26	26	26	27	28	28	28	29	29	27
1981	28	28	29	29	29	29	30	30	30	30	29	28	27	25	26	26	26	27	27	29	29	29	29	28
1982	28	28	29	29	30	30	30	30	29	29	28	28	26	24	24	24	25	26	28	28	29	28	28	28
1983	-	-	26	28	28	28	29	29	29	29	28	27	25	24	24	25	26	27	27	29	28	28	27	28
1984	28	28	28	29	29	29	29	-	29	29	28	-	-	-	25	25	26	27	27	-	-	-	-	-
Average	24	25	25	25	26	26	26	26	26	26	25	24	23	22	22	22	22	23	24	25	25	25	25	25
Monthly Average	28		29		29		29		29		28		25		25		26		27		28		28	

Source: National Fisheries Direction

Table 2: Coastal Wind System (1973-1994) at Cotonou-Cadjèhoun station

Month	Humidity		Wind	
	Average AM	Average PM	Direction	Velocity m/s
January	89%	67%	Sw	4
February	89%	70%	Sw	5
March	88%	72%	Sw	5
April	88%	72%	Sw	5
May	91%	75%	Sw	4
June	92%	79%	Sw	5
July	91%	80%	Sw	6
August	91%	79%	Sw	6
September	91%	78%	Sw	6
October	91%	76%	Sw	5
November	93%	71%	Sw	4
December	92%	68%	Sw	4

Source: NOAA

Table 3: Sea temperature and salinity Variations according to the depth

Season	Parameters	Depth														
		10	15	20	25	30	35	40	45	50	55	60	65	70	75	80
Hot Season	O°C	27,8	27,7	27,5	26,8	25,5	24,8	23,8	22,5	21,1	19,2	19,0	18,8	18,0	18,0	17,9
	S‰	34,2	34,4	34,4	34,5	34,9	35,0	34,9	35,3	35,5	35,7	35,6	35,6	35,7	35,7	35,7
Cold Season	O°C	24,7	22,7	22,0	20,8	20,1	20,0	17,1	19,1	18,6	18,7	18,6	18,2	17,5	16,6	16,3
	S‰	35,6	35,8	35,8	35,8	35,8	35,8	35,8	35,8	35,8	35,7	35,7	35,8	35,8	35,7	35,6

Source: CRHOB (Survey data 1994)

Table 4: Sardinella's Production

Month	Jan.	Febr	Marc	Apr	May	Jun	July	Agst	Sept	Oct	Nov	Dec
1994	24,0	2,2	3,0	9,1	7,2	3,0	0,8	1,4	1,3	3,9	14,6	4,0
1997	0,0	0,0	19,3	32,4	70,8	105,2	118,7	142,2	33,7	73,0	406,2	216,5
1998	156,6	218,4	81,3	97,2	53,6	18,3	48,6	126,0	81,4	139,1	320,6	154,2
1999	105,1	146,5	35,4	29,5	36,5	43,1	29,1	78,8	94,8	101,3	186,0	186,5
Annual Average	71,4	91,8	34,7	42,1	42,0	42,4	49,3	87,1	52,8	79,3	231,9	140,3

Source: National Fisheries Direction

Table 5: Average air Temperature at 9 m up to the land in Cotonou-Cadjèhoun station

Year	Jan	Febr	March	Apr	May	Jun	July	Agst	Sept	Oct	Nov	Dec
1975	26,4	27,7	29,0	28,7	27,4	26,2	25,7	24,8	25,0	26,3	27,4	26,6
1976	26,8	28,1	28,7	28,2	27,4	26,0	25,2	24,6	25,4	26,2	27,3	27,4
1977	27,9	28,7	29,1	29,4	28,3	26,7	26,5	25,2	26,4	27,4	28,2	27,4
1978	27,7	29,2	28,8	27,9	28,1	26,3	25,2	25,6	25,8	26,8	27,3	28,0
1979	28,3	29,0	28,9	29,3	27,8	26,6	25,9	26,2	26,6	26,9	28,1	27,6
1980	28,3	28,8	29,4	29,3	27,6	26,8	25,9	25,9	26,4	27,0	27,7	26,6
1981	27,4	29,0	29,2	29,1	27,8	27,0	25,9	25,7	25,9	27,3	27,9	28,6
1982	27,7	28,7	29,1	28,8	27,5	26,4	25,1	25,0	26,0	26,7	27,3	27,7
1983	25,9	27,9	29,4	29,3	28,3	26,2	25,5	25,3	26,3	27,7	28,5	27,4
1984	28	28,7	29,5	28,9	28,2	26,7	25,9	25,8	25,8	26,7	27,9	27,2
YearAver.	27,4	28,6	29,1	28,9	27,8	26,5	25,7	25,4	26,0	26,9	27,8	27,4

Source: NOAA

Climate in the Benin coastal zone

The Benin coastal zone experience a tropical climate consisting of rainy seasons (December to March, August to September). The climate characteristics of the area are influenced by the tropics associated with the movement of the sun and the relative position of the Inter-tropic Discontinuity (ITD). It is also governed by two air masses, the south westerlies and the north east harmattan dry wind

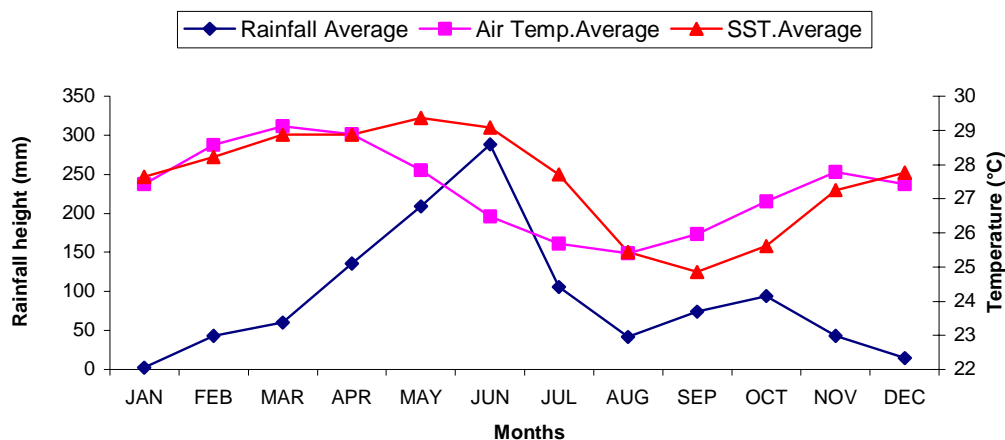


Fig. 6: Rainfall, Air temperature and Sea surface temperature variation

Air Temperature

Temperatures in the Benin Coastal zone are relatively high varying from 25,4° to 30°c

Highest values are recorded in February, March, April and lowest temperature between 25,4; 26,9°c are recorded in July August, September.

Surface Wind

Benin coastal area experiences mainly the southwesterlies which are on shore confirmed generally to azimuths 22° - 27° with velocity of 4-6m/s.

Rainfall Regime

Seasonal variations in rainfall are controlled by the seasonal displacements of the ITCZ (Hastenrath 1985) Maximum rainfall occurs in the coastal area where the thickness of the humid southwesterly monsoon air mass is greater than 15 km. There are two period of peak rains: May –June and October – November.

The Coastal rainfall is a modulated also by the coastal ocean temperature.

The concept of dry season is this relative in the zone, it does not have there a really dry season because the dry season of winter and of summer bring week precipitations (Leroux 1970)

The analysis of the mode of precipitations leads us to think that they could be the modifications of the zone circulation of the atmosphere and which could be mainly responsible for space-temporal variations of pluviometry.

The influence of the continental wind at the end of the course of harmattan reaches only exceptionally the coast, in a variable way according to years and strength of the generating Sahara Anticyclon.

Principal water masses

The various categories of water defined in the Gulf Of the Guinea concerning Benin continental shelf (CROSNIER and BERRIT, 1963) are:

- Guinean water hot and freed of salt (temperature higher than 24°C, salinity lower than 35‰)
- Hot tropical water, salted, especially on the areas of strong insolation and weak precipitations located below hot water.

Comparison of temperatures and salinity variations

- Salinity variation precede temperatures variation at least a month for the first two phases and more than two months for the two last months;
- Strongest salinities are recorded in August, the highest temperatures are generally observed in April.

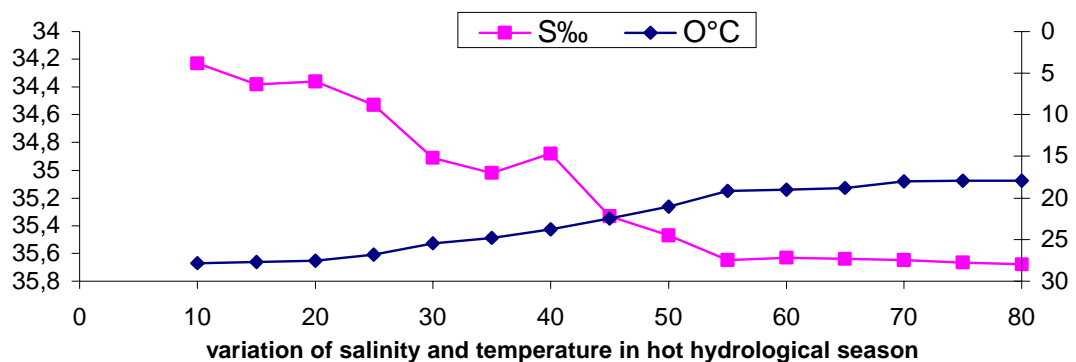


Fig. 2.a: Temperature and salinity according to the depth

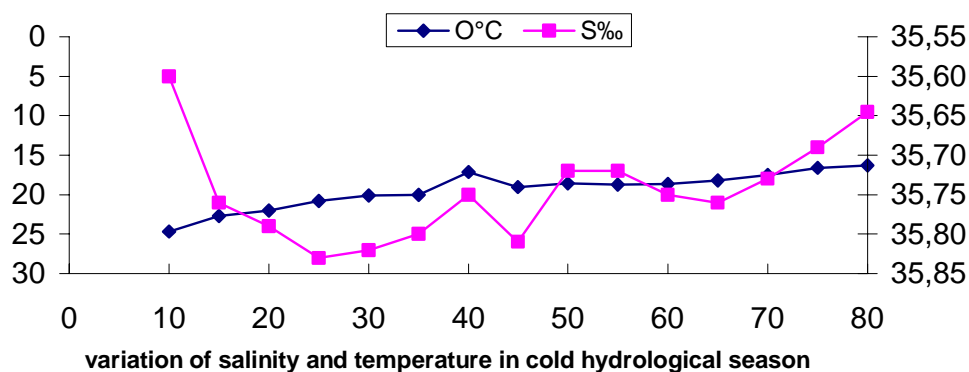


Fig.2.b: Temperature and salinity according to the depth

The coastal hydrological mode is characterized by four (4) distinct periods:

- salinity lower and water cooling for three month;
- water reheating (four (4) months) and salinity increasing (two (2) months);
- salinity reduction (four (4) months) and water cooling (Two '2) months);
- salinity rise (three (3) months) and water reheating (three (3) months).

Temperature and salinity variations causes: "upwelling"

Temperatures and salinities vary in the same direction for five (5) months; they grow in February, March and August, and decrease during May and June. Temperature and salinity graph in 50m depth show that in July, August and September, there is a salted cold water invasion.

Temperature and salinity variation have some effect on the fishes production. For example *sardinella sp.* Capture depend of the variation of two parameters.

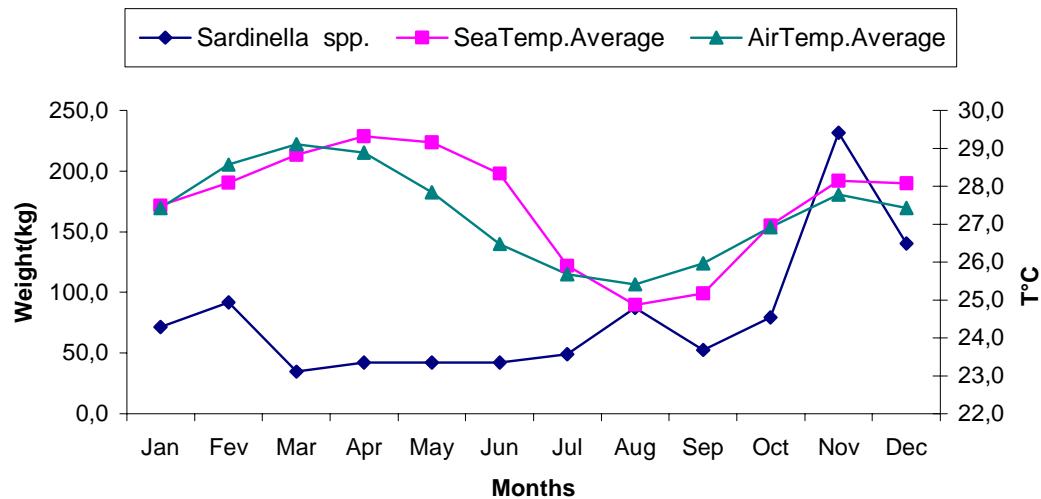


Fig. 3: Monthly sardinella production, sea temperature and air temperature variation

Conclusion

Benin is under the southern mode influence. This mode is hot period centred over February and cold period in August.

The Western part of the continental Benin Shelf belongs to the zone of "Upwelling" phenomenon. The rainfall regime, as well as the temperature patterns, the winds determine the hydrological characters and consequently the favour periods for the Fishing.

The influence of the rainfall regime is determining on the characters of continental and marine hydrology biology of species.

MAIN FISHERIES SEASONS IN THE BENIN COASTAL ZONE

Waters	Jan	Febr	March	Apr	May	June	Jul	Aug	sept	Oct	Nov	Dec
Aheme Lake	xxx xxx	/// xxx	//// ***	///	xxx	xxx					xxx ***	xxx ***
Mono Lake	xxx	Xxx									xxx	xxx
Lagoons	-----	-----	****	xxx ****	xxx ****	xxx ****	xxx ****	****				****
Sea waters	xxxx	xxxx ****	xxxx ****	****	****		///	///	/// -----	Xxxx -----	Xxx -----	Xxx -----

Legend

Fishes Fishing

{ xxx Period of good productivity

{ /// Period of moderated productivity

Shrimp fishing

{ *** Period of good productivity

{ ---- Period of moderated productivity